Volume 5, Issue 11, November 2015 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Tracking Eye Retina Based on Video-Based Techniques

[1]R. Bhanu, [2]R. Anju Ranjani
Department of Electronics and Communication Engg. in
Malla Reddy Engineering College for Women, RR Dist, Telengana, India

Abstract: Eye tracking has a long history in medical and psychological research as a tool for recording and studying human visual behaviour. Real-time gaze-based text entry can also be a powerful means of communication and control for people with physical disabilities. User-computer dialogues are typically one-sided, with the bandwidth 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 imbalance. 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 a convenient and natural way. This chapter describes research at NRL on developing such interaction techniques and the broader issues raised by non-command-based interaction styles. It discusses some of the human factors and technical considerations that arise in trying to use eye movements as an input medium, describes our approach and the first eye movement-based interaction techniques that we have devised and implemented in our laboratory, reports our experiences and observations on them, and considers eye movement-based interaction as an exemplar of a new, more general class of non-command-based user-computer interaction.

Keywords:Reflection Tracking,Video-based Tracking,Aucuuracy

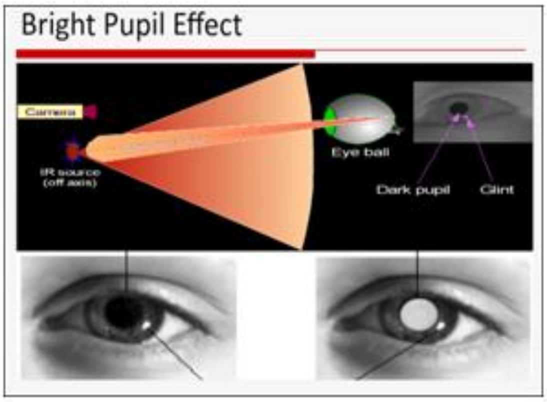
I. INTRODUCTION

In searching for better interfaces between users and their computers, an additional mode of communication between the two parties would be of great use. 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. Faster, more natural, more convenient (and, particularly, more parallel, lesss equential) means for users and computers to exchange information are needed to increase the useful bandwidth across that interface.

On the user’s side, the constraints are in the nature of the communication organs and abilities with which humans are endowed; on the computer side, the only constraint is the range of devices and interaction techniques that we can invent and their performance. Current technology has been stronger in the computer-to-user direction than user-to-computer, hence today’s user-computer dialogues are typically one-sided, with the bandwidth from the computer to the user far greater than that from user to computer. The input media that can help redress this imbalance by obtaining data from the user conveniently and rapidly. Therefore investigate the possibility of using the movements of a user’s eyes to provide a high-band width source of additional user input. While the technology for measuring a user’s visual line of gaze (where he or she is looking in space) and reporting it in real time has been improving, what is needed is appropriate interaction techniques that incorporate eye movements into the user-computer dialogue in a convenient and natural way. This chapter begins by discussing the non-command interaction style. As we all know our brains are filled with neurons, individual nerve cells connected to one another by dendrites and axons. Every time we think, move, feel or remember something, our neurons are at work. The signals are generated by differences in electric potential carried by ions on the membrane of each neuron. One can detect those signals, interrupt what they mean and use them to direct a device of some kind. Then it focuses on eye movement-based interaction as an instance of this style. It introduces a taxonomy of the interaction metaphors pertinent to eye movements. It describes studying eye movement-based interaction techniques. It discusses some of the human factors and technical considerations that arise in trying to use eye movements as an input medium,describes our approach and the first eye movement-based interaction techniques that we have devised and implemented in our laboratory, and reports our experiences and observations onthem. Finally, the chapter returns to the theme of new interaction styles and attempts to identify and separate out the characteristics of non-command styles and to consider the impact of these styles on the future of user interface software.

Non-command interface styles:

Eye movement-based interaction is one of several areas of current research in human computer interaction in which a new interface style seems to be emerging. It represents a change in input from objects for the user to actuate by specific commands to passive equipment that simply senses parameters of the user’s body. Jakob Nielsen describes this property as non-command-based.



The fifth generation user interface paradigm seems to be centered around non-command-based dialogues. This term is some what negative way of characterizing a new form of interaction but so far, the unifying concept does seem to be exactly the abandonment of the principle underlying all earlier paradigms: That a dialogue has to be controlled by specific and precise commands issued by the user and processed and replied to by the computer. The new interfaces are often not even dialogues in the traditional meaning of the word, even though they obviously can be analyzed as having some dialogue content at some level since they do involve the exchange of information between a user and a computer.

Characteristics of Eye Movements

In order to proceed with the design of effective eye movement-based human-computer interaction, we must first examine the characteristics of natural eye movements, with emphasison those likely to be exhibited by a user in front of a conventional (non-eyetracking) computer console.

Eye Retina:

The retina of the eye is not uniform. Rather, one small portion near its center contains many densely-packed receptors and thus permits sharp vision, while the rest of the retina permits only much blurrier vision. That central portion (the fovea) covers a field of view approximately one degree in diameter (the width of one word in a book held at normal reading distance or slightly less than the width of your thumb held at the end of your extended arm).Anything outside that area is seen only with ‘‘peripheral vision,’’ with 15 to 50 percent of theacuity of the fovea. It follows that, to see an object clearly, it is necessary to move the eye so that the object appears on the fovea. Conversely, because peripheral vision is so poor relative to foveal vision and the fovea so small, a person’s eye position gives a rather good indication(to within the one-degree width of the fovea) of what specific portion of the scene before the person is being examined.

Types of Eye Movements:

Human eye movements can be grouped into several categories. First, the principal method for moving the fovea to view a different portion of the visual scene is a sudden and rapid motion called a saccade. Saccades take approximately 30-120 milliseconds and traverse a range between 1 and 40 degrees of visual angle (15-20 degrees being most typical). Saccades are ballistic, that is, once begun, their trajectory and destination cannot be altered. Vision is suppressed (but not entirely prevented) during a saccade. There is a 100-300 ms. delay between the onset of a stimulus that might attract a saccade (e.g., an object appearing in peripheral vision) and the saccade itself. There is also a 200 ms refractory period after one saccade before it is possible to make another one. Typically, a saccade is followed by a 200-600 ms. period of relative stability, called a fixation, during which an object can be viewed. The purpose of a saccade appears to get an object that lies somewhere in the visual field onto one’s fovea for sharp viewing. Since the saccade is ballistic, such an object must be selected before the saccade is begun ,peripheral vision must therefore be the means for selecting the target of each saccade. During a fixation, the eye does not remain still. Several types of small, jittery motions occur, generally less than one degree in size. There is a sequence of a slow drift followed by a sudden, tiny saccade-like jump to correct the effect of the drift(a microsaccade). Super imposed on these is a high-frequency tremor, like the noise seen in an imperfect servo mechanism attempting to hold a fixed position. Another type of eye movement occurs only in response to a moving object in the visual field. This is a pursuit motion, much slower than a saccade and in synchrony with the moving object being viewed. Smooth pursuit motions cannot be induced voluntarily; they require a moving stimulus. Yet another type of movement, called nystagmus, can occur in response to motions of the head. This is a pattern of smooth motion to follow an object (as the head motion causes it to move across the visual field), followed by a rapid motion in the opposite direction to select another object (as the original object moves too far awayto keep in view). It can be induced by acceleration detected by the inner ear canals,as when a person spins his or her head around or twirls rapidly, and also by viewing and moving, repetitive pattern.

The eyes also move relative to one another, to point slightly toward each other when viewing a near object or more parallel for a distant object. Finally, they exhibit a small rotation around an axis extending from the fovea to the pupil, depending on neck angle and other factors.Thus the eye is rarely entirely still, even when viewing a static display. It constantly moves and fixates different portions of the visual field; it makes small, jittery motions even during a fixation; and it seldom remains in one fixation for long. Visual perception of a static scene appears to require the artificially induced changes caused by moving the eye around the scene. In fact, an image that is artificially fixed on the retina (every time the eye moves, the target immediately moves precisely the same amount) will appear to fade from view after a few seconds. The large and small motions the eye normally makes prevent this fading from occurring outside the laboratory.

II. SYSTEM ANALYSIS

Methods For Measuring Eye Movements:

For human-computer dialogues, we wish to measure visual line of gaze, rather than simply the position of the eye in space or the relative motion of the eye within the head. Visual line of gaze is a line radiating forward in space from the eye; the user is looking at some thing along that line. To illustrate the difference, suppose an eye-tracking instrument detected a small lateral motion of the pupil. It could mean either that the user's head moved in space(and his or her eye is still looking at nearly the same point) or that the eye rotated with respect to the head (causing a large change in where the eye is looking.

Electronic Methods:

The simplest eye tracking technique is electronic recording, using electrodes placed on the skin around the eye to measure changes in the orientation of the potential difference that exists between the cornea and the retina. However, this method is more useful for measuring relative eye movements (i.e., AlternateCurrent (AC) electrode measurements) than absolute position (which requires Direct current (DC) measurements). It can cover a wide range of eye movements, but gives poor accuracy (particularly in absolute position).

Mechanical Methods:

Perhaps the least user-friendly approach uses a non-slipping contact lens ground to fit precisely over the corneal bulge. A slight suction is applied between the lens and the eye to hold it in place. The contact lens then has either a small mechanical lever, magnetic coil, or mirror attached for tracking. This method is extremely accurate, particularly for investigation of tiny eye movements, but practical only for laboratory studies. It is very awkward and uncomfortable, covers only a limited range, and interferes with blinking.

Optical/Video Methods – Single Point:

More practical methods use remote imaging of some visible feature located on the eye,such as the boundary between the sclera (white portion of the front of the eye) and iris (coloredportion)–this boundary is only partially visible at any one time, the outline of the pupil (works best for subjects with light-colored eyes or else the pupil can be illuminated so it appearslighter than the iris regardless of eye color), or the reflection off the front of the cornea of acollimated light beam shone at the eye. Any of these can then be used with photographic or video recording (for retrospective analysis) or with real-time video processing.

Optical/Video Methods – Two Point:

However, by simultaneously tracking two features of the eye that move differentially with respect to one another as the line of gaze changes, it is possible to distinguish head movements(the two features move together) from eye movements (the two move with respect to one another). The head no longer need be rigidly fixed, although it must stay within camera range(which is quite small, due to the extreme telephoto lens required). Both the corneal reflection(from the light shining on the eye) and outline of the pupil (illuminated by the same light) are tracked. Infrared light is used, which is not disturbing to the subject. Then absolute visual line of gaze is computed from the relationship between the two tracked points.

Eye Movements In A Human-Computer Interaction:

The most naive approach to using eye position as an input might be to use it as a direct substitute for a mouse: changes in the user's line of gaze would directly cause the mouse cursor to move. This turns out to be an unworkable (and annoying) design. There are two culprits for why direct substitution of an eye tracker for a mouse is not possible. The first is the eye itself, the jerky way it moves and the fact that it rarely sits still, even when its owner thinks he or she is looking steadily at a single object; the other is the instability of the available eye tracking hardware. There are significant differences between a manual input source like the mouse and eye position; some are advantages and some, disadvantages; they must all be considered in designing eye movement-based interaction techniques:

First, eye movement input is faster than other current input media. Before the user operates any mechanical pointing device, he or she usually looks at the destination to which he wishes to move. Thus the eye movement is available as an indication of the user's goal before he or she could actuate any other input device.

Second, it is easy to operate. No training or particular coordination is required of normal users for them to be able to cause their eyes to look at an object; and the control-to-display relationship for this device is already established in the brain.

The eye is, of course, much more than a high speed cursor positioning tool. Unlike any other input device, an eye tracker also tells where the user's interest is focussed.By the very act of pointing with this device, the user changes his or her focus of attention; and every change of focus is available as a pointing command to the computer. This same quality is the prime drawback of the eye as a computer input device.Moving one's eyes is often an almost subconscious act. Unlike a mouse, it is relatively difficult to control eye position consciously and precisely at all times. The eyes continually dart from spot to spot, and it is not desirable for each such move to initiate a computer command. Similarly, unlike a mouse, eye movements are always ''on.'' There is no natural way to indicate when to engage the input device, as there is with grasping or releasing the mouse. Closing the eyes is rejected for obvious reasons even with eye tracking as input, the principal function of the eyes in the user-computer dialogue is for communication to the user. Using blinks as a signal is unsatisfactory because itdetracts from the naturalness possible with an eye movement-based dialogue by requiring the user to think about when to blink. Also, in comparison to a mouse, eye tracking lacks an analogue of the integral buttons most mouse have. Using blinks or eye closings for this purpose is rejected for the reason mentioned. Finally, the eye tracking equipment is far less stable and accurate than most manual input devices.

III. RELATED WORK

''Midas touch'' Problem

The problem with a simple implementation of an eye tracker interface is that people are not accustomed to operating devices simply by moving their eyes. They expect to be able to look at an item without having the look ''mean'' something. At first, it is empowering to be able simply to look at what you want and have it happen, rather than having to look at it (as you would anyway) and then point and click it with the mouse. Before long, though, it becomes like the Midas touch. Everywhere you look, another command is activated; you cannot look anywhere without issuing a command. The challenge in building a useful eye tracker interface is to avoid this Midas touch problem. Ideally, the interface should act on the user's eye input when he or she wants it to and let the user just look around when that's what he wants, but the two cases are impossible to distinguish in general. Instead, we investigate interaction techniques that address this problem in specific cases.

Jitter of Eye:

During a fixation, a user generally thinks he or she is looking steadily at a single object–he is not consciously aware of the small, jittery motions. This suggests that the human-computer dialogue should be constructed so that it, too, ignores those motions, since, ideally, it should correspond to what the user thinks he or she is doing, rather than what his eye muscles are actually doing. This will require filtering of the raw eye position data to eliminate the high-frequency jitter, but at the same time we must not unduly slow response to the high-frequency component of a genuine saccade.

Multiple ''Fixations'' in a Single ''Gaze'':

A user may view a single object with a sequence of several fixations, all in the general area of the object. Since they are distinct fixations, separated by measurable saccades larger than the jitter mentioned above, they would be reported as individual fixations. Once again, if the user thinks he or she is looking at a single object, the user interface ought to treat the eye tracker data as if there were one event, not several. Therefore, following the approach of Just and Carpenter , if the user makes several fixations near the same screen object, connected by small saccades, we group them together into a single ''gaze.'' Further dialogue processing is performed in terms of these gazes, rather than fixations, since the former should be more indicative of the user's intentions.

IV. IMPLEMENTATION

Interaction Techniques:

Interaction techniques provide a useful focus for this type of research because they are specific, yet not bound to a single application. An interaction technique represents an abstraction of some common class of interactive task, for example, choosing one of several objects shown on a display screen. Research in this area studies the primitive elements of human-computer dialogues, which apply across a wide variety of individual applications. The goal is to add new, high-bandwidth methods to the available store of input/output devices, interaction techniques, and generic dialogue components. Mockups of such techniques are then studied by measuring their properties, and attempts are made to determine their composition rules. This section describes the first few eye movement-based interaction techniques that we have implemented and our initial observations from using them.

Object Selection:

This task is to select one object from among several displayed on the screen, for example, one of several file icons on a desktop or, one of several ships on a map in a hypothetical ''command and control'' system. With a mouse, this is usually done by pointing at the object and then pressing a button. With the eye tracker, there is no natural counterpart of the button press. As noted, we rejected using a blink and instead tested two alternatives. In one, the user looks at the desired object then presses a button on a keypad to indicate his or her choice the user has looked at ship ''EF151'' and caused it to be selected (for attribute display, described below). The second alternative uses dwell time–if the user continues to look at the object for a sufficiently long time, it is selected without further operations. The two techniques are actually implemented simultaneously, where the button press is optional and can be used to avoid waiting for the dwell time to expire, much as an optional menu accelerator key is used to avoid traversing a menu. The idea is that the user can trade between speed and a free hand: if the user needs speed and can push the button he or she need not be delayed by eye tracker dwell time; if the user does not need maximum speed, then object selection reverts to the more passive eye-only mode using dwell time.

Continuous Attribute Display:

A good use of this object selection interaction technique is for requesting further details or attributes of one of the objects on a display. Our approach is to provide a separate area of the display where such attributes are always shown. The window on the right is a geographic display of ships, while the text window on the left shows some attributes of one of the ships, as selected by the user's eye movement. The idea is that the user can look around the ship window as desired. Whenever the user looks over to the text window, he or she will find the attribute display for the last ship looked at–presumably the one the user is interested in. However, if the user simply looks at the ship window and never looks at the text area, he or she need not be concerned that his eye movements are causing commands in the text window.

Eye Tracking Techniques:

While a large number of different techniques to track eye movements have been investigated in the past, three eye tracking techniques have emerged as the predominant ones and are widely used in research and commercial applications today. These techniques are (1) video oculography (VOG), video based tracking using head-mounted or remote visible light video cameras, (2) video-based infrared (IR) pupil-corneal reflection (PCR), and (3) Electro oculography (EOG). While particularly the first two video-based techniques have a lot of properties in common, all techniques have application areas where they are most useful.

Video-Based Tracking:

A video-based eye tracking system can be either used in a remote or head-mounted configuration. A typical setup consists of a video camera that records the movements of the eye(s) and a computer that saves and analyses the gaze data. The frame rate and resolution of the video camera have a significant effect on the accuracy of tracking; a low-cost web camera cannot compete with a high-end camera with high-resolution and high sample rate. The focal length of the lens, the angle, as well as the distance between the eye and the camera has an effect on the working distance and the quality of gaze tracking.

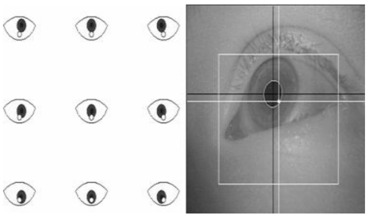


Fig: The relationship between the pupil center and the corneal reflection when the user fixates on different locations on the screen

Infrared Pupil-Corneal Reflection Tracking

Systems only based on visible light and pupil center tracking tend to be inaccurate and sensitive to head movement. To address this problem, a reference point, a so called ''corneal reflection'' or glint, can be added. Such a reference point can be added by using an artificial infrared (IR) light source aimed on- or off-axis at the eye. An on-axis light source will result in a ''bright pupil'' effect, making it easier for the analysis software to recognize the pupil in the image. The effect is similar to the red-eye effect caused by flash in a photograph. Electrooculo graphy is not dependent or disturbed by lighting conditions and thus can replace VOG-based tracking in some of these situations and for some applications.

Electrooculography-Based Tracking:

The human eye can be modelled as a dipole with its positive pole at the cornea and its negative pole at the retina. Assuming a stable cornea-retinal potential difference, the eye is the origin of a steady electric potential field. The electrical signal that can be measured from this field is called the electrooculogram (EOG). The signal is measured between two pairs of surface electrodes placed in periorbital positions around the eye with respect to a reference electrode. One drawback of EOG compared to video-based tracking is the fact that EOG requires electrodes to be attached to the skin around the eyes.

Eye Tracker Calibration and Accuracy:

Before a remote video-based eye tracking system can map gaze onto a screen, it must be calibrated to that screen for each user. Gaze mapping is more challenging for mobile head-mounted eye trackers as, in contrast to remote eye trackers, the user and thus eye tracker cannot be assumed to be positioned in a fixed location or distance relative to the screen to which the tracker was initially calibrated. Even if the eye tracker was perfectly accurate, it may still be impossible to know the exact pixel the user is focused on. This is because everything within the fovea is seen in detail and the user can move attention within this area without voluntarily moving her eyes. Besides, the eyes perform very small, rapid movements, so-called micro saccades, even during fixations to keep the nerve cells in the retina active and to correct slight drifting in focus. This may have an effect on the Responsiveness of the system, especially if the sample rate of the camera is low.

Moving an Object:

Another important interaction technique, particularly for direct manipulation systems, is moving an object on the display. We experimented with two methods. Our initial notion was that, in a direct manipulation system, a mouse is typically used for two distinct operations–selecting an object to be manipulated and performing the manipulation. The two functions could be separated and each assigned to an appropriate input device. In particular, the selection could be performed by eye position, and the hand input device devoted exclusively to the manipulations. We therefore implemented a technique whereby the eye selects an object (ship) to be manipulated (moved on the map, in this case) and then the mouse

is used to move it. The eye selection is made precisely as in the previously-described interaction techniques. Then, the user grabs the mouse, presses a button, drags the mouse in the direction the object is to be moved, and releases the button. There is no visible mouse cursor in this scheme, and the mouse is used as a relative position device–it starts moving from wherever the eye-selected ship was. Our second approach used the eye to select and drag the ship, and a push button to pick it up and put it down. The user selects a ship, then presses a button; while the button is depressed, the ship drags along with the user's eye. (Since the processing described previously is performed on the eye movements, the ship actually jumps to each fixation after about 100 ms. and then remains steadily there–despite actual eye jitter–until the next fixation.) When the button is released, the ship is left in its new position.

Eye-controlled Scrolling Text:

A window of text is shown, but not all of the material to be displayed can fit at the bottom left, a row of arrows appears below the last line of the text and above the first line, indicating that there is additional material not shown. If the user looks at the arrows, the text itself starts to scroll. Note, though, that it never scrolls when the user is actually reading the text (rather than looking at the arrows). The assumption is that, as soon as the text starts scrolling, the user's eye will be drawn to the moving display and away from the arrows, which will stop the scrolling. The user can thus read down to end of the window, then, after he or she finishes reading the last line, look slightly below it, at the arrows, in order to retrieve the next part of the text. The arrows are visible above and/or below text display only when there is additional scrollable material in that direction.

Menu Commands:

Another interaction technique is choosing a command from a menu. Since pop-up menus inherently assume a button, we used a pull-down menu. The body of the menu will appear on the screen. Next, the user can look at the items shown on the menu. After a brief look at an item (100 ms.), it will be highlighted, but its command will not yet be executed. This allows the user time to examine the different items on the menu. If the user looks at one item for a much longer time (1 sec.), its command will be executed and the menu erased.

Alternatively, once the item is highlighted, pressing a button will execute its command immediately and erase the menu. If the user looks outside the menu (for 600 ms.), the menu is erased without any command executed. Finally, to the broader question of the nature of future human-computer interaction styles. Eye movement-based interaction provides an example of several of the characteristics–as well as the problems–of what seems to be an emerging new user-computer interaction style. The new style, which combines the non-command attribute with other somewhat correlated characteristics, is seen most dramatically in virtual reality interfaces, but its characteristics are common to a more general class of rich user-computer environments, such as new types of games, musical accompaniment systems, interactive entertainment media, as well as eye movement-based interfaces. They all share a higher degree of interactivity than previous interfaces–continuous input/output exchanges occurring in parallel, rather than one x dialogue.

V. CONCLUSION

Video-based eye tracking is a common technique used to track eye movements. Head-mounted video-based eye trackers allow subjects to perform natural tasks under minimum restraint by the eye tracking apparatus. With the improved flexibility of head-mounted trackers, specifically those mounted on eyeglass frames, comes the possibility of movement of the apparatus that will undesirably affect the tracked eye-in-head (angular orientation) output. This unavoidable effect is the result of tracked eye features – the pupil and CR – being displaced in the eye images due to translational movements of the eye tracking camera with respect to the subject's eye. Therefore, in order to separate these translational movements from rotational eye movements, we have determined the relationships between pupil and CR displacements during these two types of movements. We focus on true rotational eye movements within the head about the eye's rotational centre and translational eye movements due to relative movements between the eye and the eye tracking apparatus.

REFERENCES

[1] Alapetite A, Hansen JP, MacKenzie IS (2012) Demo of gaze controlled flying. In: Proceedings of the 7th Nordic conference on human-computer interaction: making sense through design, NordiCHI'12. ACM, New York, pp 773–774.

[2] Ashmore M, Duchowski AT, Shoemaker G (2005) Efficient eye pointing with a fisheye lens. In: Proceedings of graphics interface 2005, GI'05. Canadian Human-Computer Communications Society, Waterloo, Ontario, pp 203–210.

[3] Aslin, R. N. (1981). Development of smooth pursuit in human infants. In D. F. Fisher, R. A. Monty, and J. W. Senders (Eds.), Eye Movements: Cognition and Visual Perception. Hillsdale, N.J.: Lawrence Erlbaum Associates (pp. 31-51).

[4] Finocchio D. V., Preston K. L, & Fuchs A. F. (1990). Obtaining a quantitative measure of eye movements in human infants: A method of calibrating the electrooculogram.. Vision Research, 30, 1119-28.

[5] Kowler, E. (Ed.) (1990). Eye movements and their role in visual and cognitive processes. Reviews of oculomotor research, Vol. 4. Amsterdam: Elsevier.

[6] Teller, D. Y. & Lindsey, D. T. (1993). OKN nulling techniques and infant color vision. In: C. Granrud (Ed.), Visual perception and cognition in infancy. Hillsdale, N.J.: Lawrence Erlbaum Associates.

[7] Barea F, Boquete L, Mazo M, Lopez E (2002) System for assisted mobility using eye movements based on electrooculography. IEEE Trans Neural Syst Rehabil Eng 10(4):209–218.

[8] Bates R, Donegan M, Istance HO et al (2006) Introducing COGAIN—communication by gaze interaction. In: Clarkson J, Langdon P, Robinson P (eds) Designing accessible technology. Springer, London, pp 77–84.

[9] Bednarik R, Vrzakova H, Hradis M (2012) What you want to do next: a novel approach for intent prediction in gaze-based interaction. In: Proceedings of the symposium on eye tracking research and applications, ETRA'12. ACM, New York, pp 83–90.

[10] Bulling A, Cheng S, Brône G et al (2012a) 2nd international workshop on pervasive eye tracking and mobile eye-based interaction (PETMEI 2012). In: Proceedings of the 2012 ACM conference on ubiquitous computing, UbiComp 2012. ACM, New York, pp 673–676.

[11] Canosa RL (2009) Real-world vision: selective perception and task. ACM Trans Appl Percept 6(2):article 11, 34 pp.

[12] Drewes H, Schmidt A (2007) Interacting with the computer using gaze gestures. In: Proceedings of INTERACT '07. Lecture notes in computer science, vol 4663. Springer, Heidelberg, pp 475-488.

[13] Friedman MB, Kiliany G, Dzmura et al (1982) The eyetracker communication system. Johns Hopkins APL Technical Digest 3(3):250–252.

AUTHOR'S PROFILE

Ms. R. Bhanu, Post Graduated in Systems and Signal Processing (**M.Tech**) From **JNTUH**, in 2013 and Graduated in Electronics and Communication Engineering (B.Tech) from JNTUH, in 2009. She is working as an Assistant Professor in Department of Electronics and Communication Engineering in **Malla Reddy Engineering College for Women**, R.R Dist, TS, India. She has around 4.5 years of Teaching Experience. Her Research Interests Include signal processing, image processing & communications.

Mrs. R. AnjuRanjani, PostGraduated in System and Signal Processing **(M.Tech**) From **MRCET,JNTUH** in 2012 and graduated in Electronics and Communication Engineering (B.Tech) CMRIT, JNTUH 2009. 3+ years of Teaching Experience working in **Malla Reddy Engineering College For Women(MRECW)**, R.R Dist, TS, India. Her Research interests include Image Processing, Pattern Recognition and video processing.