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# EYE MOVEMENT BASED ARCHITECTURE FOR PHYSICALLY CHALLENGED PERSONS USING MATLAB

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## ABSTRACT:

This concept presents a optical type eye tracking system to control powered applications. User‘s eye movement are translated to screen position using the optical type eye tracking system. When user looks at appropriate angle, then computer input system will send command to the software based on the angle of rotation of pupil i.e., when user moves his eyes balls u p (move forward), left (move left), right (move right) in all other cases output device will stop. Once the image has been processed it moves onto the second part, our system matlab environment. Processing of the eyeball movement is performed on MATLAB environment by employing Voila-Jones algorithm. Further, as an improvement , image enhancement is done using edge preserving filtering technique.

**KEYWORDS:** eye tracking, eyeball movement, Voila-Jones algorithm, image enhancement, edge preserving filtering.

## INTRODUCTION:

THE ability to move freely is highly valued by all people. However, it is sometimes difficult for a person with a physical disability. Nowadays, an electric wheelchair is commercially available for disabled people. It generally requires considerable skill to operate. Moreover, some disabled people cannot drive an electric wheelchair manually, even with a joystick, because they lack the physical ability to control the movement. To enable a disabled person to drive a wheelchair safely and easily so that they can enjoy a higher quality of life, researchers have proposed several electric wheelchair systems. The use of voice commands to control an electric wheelchair is one research result. A small number of command words and high-performance voice recognition are employed in this system. An electric wheelchair control with electro-oculography (EOG) techniques has also been proposed. In this case, the different commands for the wheelchair are derived from the electro-oculography (EOG) potential signals of eye movements. A system for electric wheelchair control using the eyes was proposed in 2007. A commercially available web camera on a head-mounted display (HMD) which the user wears is used to capture moving pictures of the user's face. captured image data, detecting and tracking movements of the user‘s eyes, estimating the line-of-sight vector, and actuating the electric wheelchair in the desired direction indicated by the user‘s eyes. One of the key essentials of the proposed system is detecting and tracking the eye movements. This article will be an eye movement based controlled wheelchair system. A spectacle mounted camera will track eye movement and control a wheelchair to goforward, stop, left or right. The most challenging aspects will lie in finding a good way to differentiate iris and pupil locations, determining the eye‘s movement, and controlling the wheelchair‘s wheels in proper movement. In today's world, robots have become an integral part of human life. Robots are becoming more and more pervasive in our everyday lives. Their use spans from high precision industrial manipulators to floor cleaning robots, from space exploration to assistance to first responders. It is envisioned that robots will play a major role in our future society and economy [16]. The developing field of robotic technologies has widespread applications, one of most promising field of which is Robotic Assistive Technologies, where robotic assistive devices can be used to improve the quality of life of people suffering from severe physical disabilities, ameliorating movement and communication and utilizing the latest technologies and innovations to help develop engineering applications and devices to advance mankind. The spectrum of working modalities and number of end users are constantly expanding. The domain of utilization of highly advanced robotics is penetrating from highly skilled professionals to the community users of diverse backgrounds. Along with that the ever increasing demand of multiple operating robots calls for the introduction of better technologies for robotics development at all levels.[17] Continuous research is being carried out to make the control of robots easier, simpler and user friendly. In this project, we are trying to control a robot based on eyeball movement. In recent years, the increased sophistication and accessibility of eye tracking technologies have generated a great deal of interest in the commercial sector. Applications include web usability, advertising, sponsorship, package design and automotive engineering. In general, commercial eye tracking studies function by presenting a target stimulus to a sample of consumers while an eye tracker is used to record the activity of the eye. Examples of target stimuli may include websites, television programs, sporting events, films, commercials, magazines, newspapers, packages, shelf displays, consumer systems (ATMs, checkout systems, kiosks), and software. The resulting data can be statistically analyzed and graphically rendered to provide evidence of specific visual patterns. By examining fixations, saccades, pupil dilation, blinks and a variety of other behaviors researchers can determine a great deal about the effectiveness of a given medium or product. While some companies complete this type of research internally, there are many private companies that offer eye tracking services and analysis. One of the most prominent fields of commercial eye tracking research is web usability.[citation needed] While traditional usability techniques are often quite powerful in providing information on clicking and scrolling patterns, eye tracking offers the ability to analyze user interaction between the clicks and how much time a user spends between clicks. This provides valuable insight into which features are the most eye-catching, which features cause confusion and which ones are ignored altogether. Specifically, eye tracking can be used to assess search efficiency, branding, online advertisements, navigation usability, overall design and many other site components. Analyses may target a prototype or competitor site in addition to the main client site.

## EYETRACKING:

Eye tracking is the process of measuring either the point of gaze (where one is looking) or the motion of an eye relative to the head. An eye tracker is a device for measuring eye positions and eye movement. Eye trackers are used in research on the visual system, in psychology, in psycholinguistics, marketing, as an input device for human-computer interaction, and in product design. There are a number of methods for measuring eye movement. The most popular variant uses video images from which the eye position is extracted. Other methods use search coils or are based on the electrooculogram n the 1800s, studies of eye movement were made using direct observations. In 1879 in Paris, Louis Émile Javal observed that reading does not involve a smooth sweeping of the eyes along the text, as previously assumed, but a series of short stops (called fixations) and quick saccades.[1] This observation raised important questions about reading, which were explored during the 1900s: On which words do the eyes stop? For how long? When does it regress back to already seen words? Edmund Huey[2] built an early eye tracker, using a sort of contact lens with a hole for the pupil. The lens was connected to an aluminum pointer that moved in response to the movement of the eye. Huey studied and quantified regressions (only a small proportion of saccades are regressions), and he showed that some words in a sentence are not fixated. The first non-intrusive eye trackers were built by Guy Thomas Buswell in Chicago, using beams of light that were reflected on the eye and then recording them on film. Buswell made systematic studies into reading[3] and picture viewing.[4] In the 1950s, Alfred L. Yarbus[5] did important eye tracking research and his 1967 book is often quoted. He showed the task given to a subject has a very large influence on the subject's eye movement. He also wrote about the relation between fixations and interest: "All the records ... show conclusively that the character of the eye movement is either completely independent of or only very slightly dependent on the material of the picture and how it was made, provided that it is flat or nearly flat."[6] The cyclical pattern in the examination of pictures "is dependent not only on what is shown on the picture, but also on the problem facing the observer and the information that he hopes to gain from the picture." "Records of eye movements show that the observer's attention is usually held only by certain elements of the picture.... Eye movement reflects the human thought processes; so the observer's thought may be followed to some extent from records of eye movement (the thought accompanying the examination of the particular object). It is easy to determine from these records which elements attract the observer's eye (and, consequently, his thought), in what order, and how often. "The observer's attention is frequently drawn to elements which do not give important information but which, in his opinion, may do so. Often an observer will focus his attention on elements that are unusual in the particular circumstances, unfamiliar, incomprehensible, and so on."[8] "... when changing its points of fixation, the observer's eye repeatedly returns to the same elements of the picture. Additional time spent on perception is not used to examine the secondary elements, but to reexamine the most important elements."[9] This study by Hunziker (1970)[10] on eye tracking in problem solving used simple 8 mm film to track eye movement by filming the subject through a glass plate on which the visual problem was displayed.[11][12] . In the 1970s, eye tracking research expanded rapidly, particularly reading research. A good overview of the research in this period is given by Rayner.[13] In 1980, Just and Carpenter[14] formulated the influential Strong eye-mind hypothesis, that "there is no appreciable lag between what is fixated and what is processed". If this hypothesi is correct, then when a subject looks at a word or object, he or she also thinks about it (process cognitively), and for exactly as long as the recorded fixation. The hypothesis is often taken for granted by researchers using eye tracking. However, gaze-contingent techniques offer an interesting option in order to disentangle overt and covert attentions, to differentiate what is fixated and what is processed. During the 1980s, the eye-mind hypothesis was often questioned in light of covert attention,[15][16] the attention to something that one is not looking at, which people often do. If covert attention is common during eye-tracking recordings, the resulting scan path and fixation patterns would often show not where our attention has been, but only where the eye has been looking, failing to indicate cognitive processing. The 1980s also saw the birth of using eye tracking to answer questions related to human-computer interaction. Specifically, researchers investigated how users search for commands in computer menus.[17] Additionally, computers allowed researchers to use eye-tracking results in real time, primarily to help disabled users.[18] More recently, there has been growth in using eye tracking study how users interact with different computer interfaces. Specific questions researchers ask are related to how easy different interfaces are for users.[19] The results of the eye tracking research can lead to changes in design of the interface. Yet another recent area of research focuses on Web development. This can include how users react to drop-down menus or where they focus their attention on a website so the developer knows where to place an advertisement.[20] According to

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Hoffman,[21] current consensus is that visual attention is always slightly (100 to 250 ms) ahead of the eye. But as soon as attention moves to a new position, the eyes will want to follow.[22] We still cannot infer specific cognitive processes directly from a fixation on a particulaobject in a scene.[23] For instance, a fixation on a face in a picture may indicate recognition, liking, dislike, puzzlement etc. Therefore, eye tracking is often coupled with other methodologies, such as introspective verbal protocols. The second broad category uses some non-contact, optical method for measuring eye motion. Light, typically infrared, is reflected from the eye and sensed by a video camera or some other specially designed optical sensor. The information is then analyzed to extract eye rotation from changes in reflections. Video-based eye trackers typically use the corneal reflection (the first Purkinje image) and the center of the pupil as features to track over time. A more sensitive type of eye tracker, the dual-Purkinje eye tracker,[25] uses reflections from the front of the cornea (first Purkinje image) and the back of the lens (fourth Purkinje image) as features to track. A still more sensitive method of tracking is to image features from inside the eye, such as the retinal blood vessels, and follow these features as the eye rotates. Optical methods, particularly those based on video recording, are widely used for gaze tracking and are favored for being non-invasive and inexpensive. The third category uses electric potentials measured with electrodes placed around the eyes. The eyes are the origin of a steady electric potential field, which can also be detected in total darkness and if the eyes are closed. It can be modelled to be generated by a dipole with its positive pole at the cornea and its negative pole at the retina. The electric signal that can be derived using two pairs of contact electrodes placed on the skin around one eye is called Electrooculogram (EOG). If the eyes move from the centre position towards the periphery, the retina approaches one electrode while the cornea approaches the opposing one. This change in the orientation of the dipole and consequently the electric potential field results in a change in the measured EOG signal. Inversely, by analysing these changes in eye movement can be tracked. Due to the discretisation given by the common electrode setup two separate movement components – a horizontal and a vertical – can be identified. A third EOG component is the radial EOG channel,[26] which is the average of the EOG channels referenced to some posterior scalp electrode. This radial EOG channel is sensitive to the saccadic spike potentials stemming from the extra-ocular muscles at the onset of saccades, and allows reliable detection of even miniature saccades.[27] Due to potential drifts and variable relations between the EOG signal amplitudes and the saccade sizes make it challenging to use EOG for measuring slow eye movement and detecting gaze direction. EOG is, however, a very robust technique for measuring saccadic eye movement associated with gaze shifts and detecting blinks. Contrary to video-based eye-trackers, EOG allows recording of eye movements even with eyes closed, and can thus be used in sleep

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research. It is a very light-weight approach that, in contrast to current video-based eye trackers, only requires very low computational power, works under different lighting conditions and can be implemented as an embedded, self-contained wearable system.[28] It is thus the method of choice for measuring eye movement in mobile daily-life situations and REM phases during sleep. The major disadvantage of EOG is its relatively poor gaze direction accuracy compared to a video tracker. That is, it is difficult using EOG to determine with good accuracy exactly where a subject is looking, though the time of eye movements can be determined.

**VIOLA–JONES**:The Viola–Jones object detection framework is the first object detection framework to provide competitive object detection rates in real-time proposed in 2001 by Paul Viola and Michael Jones.[1][2] Although it can be trained to detect a variety of object classes, it was motivated primarily by the problem of face detection. The characteristics of Viola–Jones algorithm which make it a good detection algorithm are:

- Robust – very high detection rate (true-positive rate) & very low false-positive rate always.
- Real time – For practical applications at least 2 frames per second must be processed.
- Face detection only (not recognition) - The goal is to distinguish faces from non-faces (detection is the first step in the recognition process).

The algorithm has four stages:

1. Haar Feature Selection
2. Creating an Integral Image
3. Adaboost Training
4. Cascading Classifiers

The features sought by the detection framework universally involve the sums of image pixels within rectangular areas. As such, they bear some resemblance to Haar basis functions, which have been used previously in the realm of image-based object detection.[3] However, since the features used by Viola and Jones all rely on more than one rectangular area, they are generally more complex. The figure on the right illustrates the four different types of features used in the framework. The value of any given feature is the sum of the pixels within clear rectangles subtracted from the sum of the pixels within shaded rectangles. Rectangular features of this sort are primitive when compared to alternatives such as steerable filters. Although they are sensitive to vertical and horizontal features, their feedback is considerably coarser.

1. Haar Features – All human faces share some similar properties. These regularities may be matched using **Haar Features**.

A few properties common to human faces:

- The eye region is darker than the upper-cheeks.

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- The nose bridge region is brighter than the eyes.

Composition of properties forming matchable facial features:

- Location and size: eyes, mouth, bridge of nose
- Value: oriented gradients of pixel intensities

The four features matched by this algorithm are then sought in the image of a face (shown at left).

Rectangle features:

- Value = Σ (pixels in black area) - Σ (pixels in white area)
- Three types: two-, three-, four-rectangles, Viola & Jones used two-rectangle features
- For example: the difference in brightness between the white &black rectangles over a specific area
- Each feature is related to a special location in the sub-window

2. An image representation called the integral image evaluates rectangular features in *constant* time, which gives them a considerable speed advantage over more sophisticated alternative features. Because each feature's rectangular area is always adjacent to at least one other rectangle, it follows that any two-rectangle feature can be computed in six array references, any three-rectangle feature in eight, and any four-rectangle feature in nine.

The integral image at location (x,y), is the sum of the pixels above and to the left of (x,y), inclusive.

## EYE BALL DIRECTION DETECTION:

Looking straight ahead or with eyes that are defocused/unmoving is also considered a sign of visual accessing. A typical left-handed person would have the opposite meanings for their eye-directions.*** As with other signs of lying, you should first establish and understand a persons base-behavior before concluding they are lying by the direction of their eyes. Many critics believe the above is a bunch of bull***t. In my own experiments I have found these techniques to be more true than not. But, why not find out for yourself? Make up a list of questions that like the sample ones, and give them to your friends/family anyone who would be your guinea pig, observe their eye movements and record the results. The Eye Direction is calculated using the pupil center and the cornea curvature cente instead of the eyeball center in the eye direction model. A Shape of the projected pupil is approximated as an ellipse flattened by a rotation angle of the pupil. The Flattening is provided with theye direction as a rotation angle of the pupil. However, Examineeís personal information of the eyeball is essential to the eye direction detection, which consist of a cornea curvature radius, a distance between the cornea curvature center and the pupil rim, and a gap of the fovea. Once They are measured as absolute values, on-site

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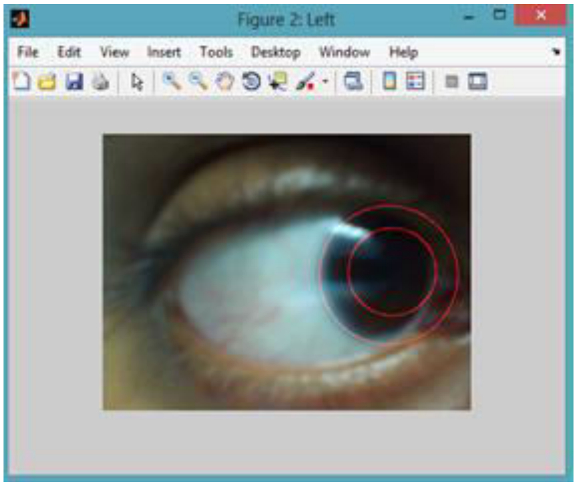
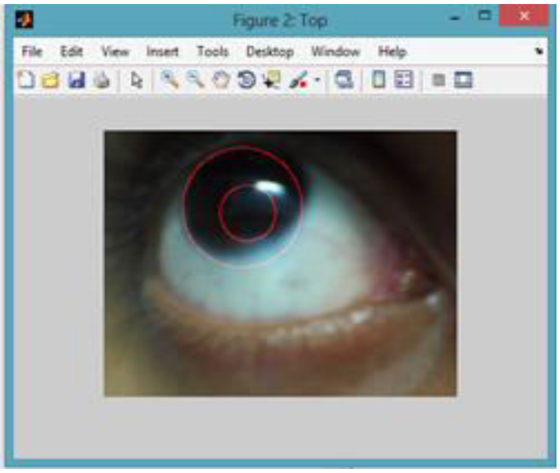
calibration is not required no any more for our eye direction model. The Eye directio detection constructs three steps. First, A tentative cornea curvature center is approximated using cornea reflections from four LEDs Around a camera lens and the cornea curvature radius measured as the personal information. Next, A shape of the pupil is approximated as an ellipse by Hough Transform using outline edges of a projected pupil in the image. Ordinarily, An ellipse Hough Transform is performed using 5 Degree of freedom as parameters. Our Eye direction model enables us to reduce the degree of freedom to 3. That Is only the pupil center and the pupilradius. Approximation Of the pupil shape by ellipse Hough Transform is also performed varying the cornea curvature center. And then, the eye direction is estimated by calculating the rotation angle of the pupil

## EDGE PRESERVING FILTER:

Edge-preserving smoothing is an image processing technique that smooths away textures whilst retaining sharp edges. Examples are the Bilateral filter, the Guided filter and Anisotropic diffusion. An alternative to linear filtering, called anisotropic diffusion, was introduced by Perona and Malik. It is related to earlier work by Grossberg who used a similar nonlinear diffusion processes to model human vision. The motivation for anisotropic diffusion (also called nonuniform or variable conductance diffusion) is that a Gaussian smoothed image is a single time slice of the solution to the heat equation, that has the original image as its initial conditions. Anisotropic diffusion includes a variable conductance term that, in turn, depends on the differential structure of the image. Thus, the variable conductance can be formulated to limit the smoothing at "edges" in images, as measured by high gradient magnitude. In image processing and computer vision, anisotropic diffusion, also called Perona–Malik diffusion, is a technique aiming at reducing image noise without removing significant parts of the image content, typically edges, lines or other details that are important for the interpretation of the image.[1][2][3] Anisotropic diffusion resembles the process that creates a scale space, where an image generates a parameterized family of successively more and more blurred images based on a diffusion process. Each of the resulting images in this family are given as a convolution between the image and a 2D isotropic Gaussian filter, where the width of the filter increases with the parameter. This diffusion process is a linear and space-invariant transformation of the original image. Anisotropic diffusion is a generalization of this diffusion process: it produces a family of parameterized images, but each resulting image is a combination between the original image and a filter that depends on the local content of the original image. As a consequence, anisotropic diffusion is a non-linear and space-variant transformation of the original image. In its original formulation, presented by Perona and Malik in 1987,[1] the space-variant filter is in fact isotropic but depends on the image content such that it approximates an impulse function close to edges and other structures that should be preserved in the image over the different levels of the resulting scale space. This formulation was referred to as anisotropic diffusion by Perona and Malik even though the locally adapted filter is isotropic, but it has also been referred to as inhomogeneous and nonlinear diffusion[4] or Perona-Malik diffusion[5] by other authors. A more general formulation allows the locally adapted filter to be truly anisotropic close to linear structures such as edges or lines: it has an orientation given by the structure such that it is elongated along the structure and narrow across. Such methods are referred to as shape-adapted smoothing[6][7] or coherence enhancing diffusion.[8] As a consequence, the resulting images preserve linear structures while at the same time smoothing is made along these structures. Both these cases can be described by a generalization of the usual diffusion equation where the diffusion coefficient, instead of being a constant scalar, is a function of image position and assumes a matrix (or tensor) value (see structure tensor). Although the resulting family of images can be described as a combination between the original image and space-variant filters, the locally adapted filter and its combination with the image do not have to be realized in practice. Anisotropic diffusion is normally implemented by means of an approximation of the generalized diffusion equation: each new image in the family is computed by applying this equation to the previous image. Consequently, anisotropic diffusion is an iterative process where a relatively simple set of computation are used to compute each successive image in the family and this process is continued until a sufficient degree of smoothing is obtained.

## RESULT:



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## CONCLUSION:

This concept has presented a wheelchair system using eye movements, in which pupil detection that is segmentation is done using Daugman's algorithm and deduction of direction in which pupil looks is decided by fixing range to the particular direction as user looks. Detection of pupil is done even on illumination unless the illumination is covering whole eye, this is because when the light hits the pupil and illumination spreads on the pupil covering whole pupil which ignores those pixels so as we treat the illumination spots it will leave behind a maximum change edges that cannot be determined and the operator will consider another position to be a iris location. This process works even if image taken in little dark environment

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