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A Review on Human Computer Interaction using Eyes

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***Abstract*- The paper presents an idea to control computer mouse cursor movement with human eyes. Number of traditional techniques such as Head and Hand Movement Tracking Systems exist for cursor control by making use of image processing in which light is the primary source.**

INTRODUCTION

People with physical disabilities face a lot of problems in communication with their fellow human beings. The design of an eye-controlled mouse system with an emphasis on the *Human-Computer-Interface* (HCI) based on *Matlab* has been presented. Computers can be used by persons with disabilities for communication, environmental control, source of information and entertainment.

In the proposed system, the design of the software is in such a way that, when the user faces the camera, the pixel position will be fixed by the software. The human face recognition is given importance in order to provide facilities like pixel point determination, authentication, etc., Since the software determines the pixel point, the user need not worry about the loss of pixel point when user shakes his/her head. Because when the head is shaken fast, the pixel point gets lost, when the user again faces the camera without any movement, then the pixel point is determined again by the software. This shows that the stability of the pixel position is high compared to existing system. The cursor will not vibrate more as the stability of pixel point very high compared to the existing system.

These are the following algorithms are included for
1. Image Recognition
2. Image Detection
3. Tracking

1. Image Recognition:

An Image recognition system is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. One of the ways to do this is by comparing selected Image features from the image and an image database. It is typically used in security systems and can be compared to other biometrics such as fingerprint or eye iris recognition systems. Some facial recognition algorithms identify faces by extracting landmarks, or features, from an image of the subject's face. For example, an algorithm may analyze the relative position, size, and/or shape of the eyes, nose, cheekbones, and jaw. These features are then used to search for other images with matching features. Other algorithms normalize a gallery of face images and then compress the data, only saving the data in the image that is useful for face detection. A probe image is then compared with the data. One of the earliest, successful systems is based on template matching techniques applied to a set of salient facial features, providing a sort of compressed face representation.

Recognition algorithms can be divided into two main approaches, geometric, which looks at distinguishing features or photometric, which is a statistical approach that distill an image into values and comparing the values with templates to eliminate variances.

2. Image Detection:

Image detection is a computer technology that determines the locations and sizes of images in arbitrary (digital) images. It detects image features and ignores anything else, such as buildings, trees and bodies. Image detection can be regarded as a specific case of object-class detection; In object-class detection, the task is to find the locations and sizes of all objects in an image that belong to a given class. Examples include upper torsos, pedestrians, and cars. Early image-detection algorithms focused on the detection of frontal human faces, whereas newer algorithms attempt to solve the more general and difficult problem of multi-view image detection. That is, the detection of faces that are either rotated along the axis from the face to the observer (in-plane rotation), or rotated along the vertical or left-right axis (out-of plane rotation), or both. Many algorithms implement the image-detection task as a binary pattern-classification task. That is, the content of a given part of an image is transformed into features, after which a classifier trained on example faces decides whether that particular region of the image is a face, or not. Often, a window-sliding technique is employed. That is, the classifier is used to classify the (usually square or rectangular) portions of an image, at all locations and scales, as either faces or non-faces (background pattern).

3. Tracking:

Image is tracked by two de correlated detectors: Color-Based Face Tracker and Viola-Jones Face Detector.
Both algorithms made a good showing by their robustness and speed. They are not exacting to video quality and resolution. Our initial attempt at providing mouse movement was to track the recognition of the signs and each time new location for the sign was detected update the position of the mouse on the kiosk display. Unfortunately this resulted in unacceptably jerky movement of the mouse.

This was caused by two factors:
1. During motion the sign was not always detected because of blurring in the image. This resulted in the sign being occasionally recognized and themouse therefore being moved in jumps rather than smoothly.

2. The recognizer finds the bounding box for the gesture and takes the center point of the bounding box as the position of the sign. As the hand moves the shape of the bounding box changes and this gives rise to erratic position estimates that are unpleasing to the user. We overcame the above problems by separating the motion of the kiosk mouse pointer from the recognition of the sign.

Current algorithm achieves smooth mouse movement by using the algorithm:
Optical Flow in a Region
The optical flow in the region that contains the hand sign is computed on each frame. This provides a very smooth estimate of movement of the sign. The above algorithm provides a very smooth and usable mouse movement on the kiosk. Upon entry to the "Gesture Tracking" state a region is computed that is slightly larger than the bounding box of the hand sign which shows the bounding box and an outer box used for calculating the optical flow. The optical flow is computed for the entire optical flow region and the average flow within the region is passed into the Kalman filter. Whenever a sign isrecognized, the position in the gesture box is updated but recognition of a sign never moves the mouse pointer–only optical flow results in mouse movement.

Classification of Different Mouse Control Techniques:

There are a lot of head tracking and EOG systems for cursor control. Some of them are equipped with sophisticatedly designed systems using complicated concepts or using high quality devices such as high cost 3-D graphical hardware.

1. Head Movement Tracking System: It is a device that transmits a signal from top of the computer monitor and tracks a reflector spot placed on the user's forehead or eyeglasses. Using only the movement of the user's head, the movement of the cursor can be controlled, allowing 'The Head Mouse' to be used as an ordinary computer mouse. But problem with this technique is that some disabled people cannot even move their head comfortably, also the system becomes inaccurate if user's forehead is not facing the camera. *Eye tracking* is a technology in which a camera or imaging system visually tracks some features of the eye and then a computer determines where the user is looking at. Eye tracking technology can be divided into two areas; firstly a remote computer-mounted device, in which an IR camera is mounted on a computer screen, and secondly a head-mounted device, in which an IR camera is placed on user's head. This technique is accurate but expensive.

2. Hand Detection: It isthemostdifficultproblem in buildinga handgesture-basedinteractionsystem.Thereare severalcuesthatcanbeused:appearance,shape,color,depth, andcontext.Inproblemslikefacedetection,theappearance is a very goodindicator[7].Since ourpapermainlyfocuses on gesture recognition, it is not harmful toassume that the handis themajorportionintheimage.Sincethehandisthe majorpart,itwouldbeeasy tosegmentit byusingthe segmentationtechniques proposedby Albioletall[2].This method ofsegmentationis more relatedto humanperception asoureyescouldeasily recognizetheskintonefrom its background. This classical methodforsegmentingtheskin pixels setsupperandlowerboundvaluesusingwhichthe handwassegmented.It classifiesnoisy objects as skin; thereforenoiseremovalofthesegmentedimageisabsolutely necessary.Theimagesareresizedtoafixedresolutionbefore performing the recognitionprocess. Inourcase, the images were resized to 640 by480asthat wastheresolutionofthe camera used.

3. Electro-oculography (EOG): It is a new technology of placing electrodes on user's forehead around the eyes to record eye movements. EOG is a very small electrical potential that can be detected using electrodes. The majority of the people using this setup may have severe cerebral palsy or been born with a congenital brain disorder or suffered traumatic brain injury, for example from automobile or drowning accidents. This technique is adapted because it is inexpensive and accurate The anatomy of the eye is shown in the Fig. 1. The light entering the pupil, is focused, inverted by the cornea and lens and projected onto the back of the eye (fovea). The fovea defines the center of the eyes with the region of highestvisual acuity.
The eyes houses seven layers of alternating cells and processes which convert a light signal into a neural signal (transduction). The actual photoreceptors are the rods and cones, but the cells that transmit to the brain are the ganglion cells. Cones provide the focus on fine detail and distinguish color. They require relatively high levels of illumination to operate. Rods, on the other hand, are much more sensitive to light, providing superior capability to detect movement in low levels of illumination. The axons of the ganglion cells make up the optic nerve, the single route by which information leaves the eye.

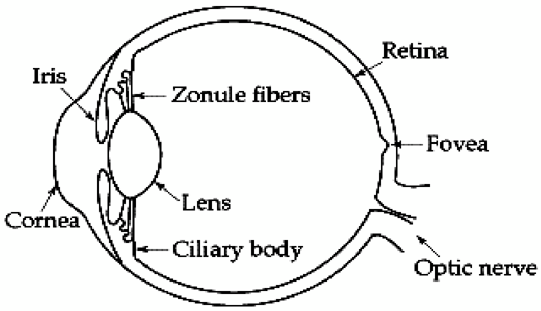

Fig.1 The anatomy of the eye

SENSING EYE SIGNALS

Duetothehighermetabolicrateattheretinacomparedto thecornea,theeyemaintainsa voltageof+0.40to +1.0 millivolts with respect to the retina. This corneoretinalpotential, which isroughly aligned with theoptic axis and hencerotateswiththe directionofgaze,canbe measuredby surface electrodes placed ontheskinaround theeyes,(see Fig.2).Theactualrecordedpotentialsaresmallerintherange of15to 200microvoltsandareusuallyamplifiedbefore processing. Withpropercalibration,the orientationof the electricdipolecanbeusedtospecifytheangularpositionof theeyeballtowithin2 degreesverticallyand1.5degrees horizontallyIndependent measurementscanbeobtained fromthetwo eyes,butasthetwoeyesmovein conjunctionin thevertical direction,it is sufficienttomeasuretheverticalmotionofonly oneeyetogetherwiththe horizontalmotionof botheyes.To detect verticalmotion, one electrode is placed 2cm above whereasanotherelectrodeisplaced1cmbelowthelefteye. Todetecthorizontalmotion,anelectrodeisplacedonouter sideof eacheyewith2cm distancefromtheeye(seeFig.2). Ag/AgClelectrodes arechosenastheirhalfcellpotentialis closertozero.

When theeyes look straight ahead, a steady dipole is createdbetweenthetwoelectrodes.Whenthegazeisshifted totheleft,thepositivecorneabecomescloserto theleft electrode, which becomes more positive , with zero potential at the right electrode, and vice versa. The EOGsignalisa resultofa numberof factors,includingeyeballand eyelidmovement, differentsourcesofartifactsuchasEEG, electrodesplacement,headmovementandinfluenceof the luminance,etc.Forthisreason,it isnecessarytoeliminatethe shiftingrestingpotential(meanvalue)becausethis value changes.Toavoidthisproblem,it isnecessarytohaveac differentialamplifierthatwilltakethedifferenceof thetwo oppositeelectrodes.

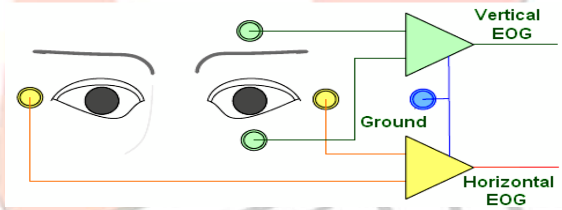

Fig.2 Correct positions of five electrodes

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