International Conference on Communication and Signal Processing, July 28 - 30, 2020, India

Eyeball based Cursor Movement Control

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***Abstract*—An individual Human computer interference system is being introduced. In olden times, as an input device the mouse and keyboard were used by human computer interference system. Those people who are suffering from certain disease or illness cannot be able to operate computers. The idea of controlling the computers with the eyes will serve a great use for handicapped and disabled person. Also this type of control will eliminate the help required by other person to handle the computer. This measure will be the most useful for the person who is without hands through which they can operate with the help of their eye movements. The movement of the cursor is directly associated with the center of the pupil. Hence our first step would be detecting the center of point pupil. This process of pupil detection is implemented using the Raspberry Pi and OpenCV. The Raspberry Pi has a SD/MMC card slot which is used for placing the SD card. The SD card is boosted with the operating system that is required starting up of Raspberry Pi. The Raspberry PI will get executed once the application program is loaded into it.**

***Index Terms*—Human Computer Interaction (HCI), Eyeball movement, Computer, OpenCV, Support Vector Machine.**

I. INTRODUCTION

AS the computer technologies are growing rapidly, the importance of human computer interaction becomes highly notable. Some persons who are disabled cannot be able to use the computers. Eye ball movement control mainly used for disabled people. Incorporating this eye controlling system with the computers will make them to work without the help of other individual. Human-Computer Interface (HCI) is focused on use of computer technology to provide interface between the computer and the human. There is a need for finding the suitable technology that makes the effective communication between human and computer. Human computer interaction plays the important role .Thus there is a need to find a method that spreads an alternate way for making communication between the human and computer to the individuals those who have impairments and give them an equivalent space to be an element of Information Society [1-5].

In recent years, the human computer interfaces are attracting the attention of various researchers across the globe. Human computer interface is an implementation of the vision-based system for eye movement detection for the disabled people.

In the proposed system, we have included the face detection, face tracking, eye detection and interpretation of a sequence of eye blinks in real time for controlling a non-intrusive human computer interface. Conventional method of interaction with the computer with the mouse is replaced with the human eye movements. This technique will help the paralyzed person, physically challenged people especially person without hands to compute efficiently and with the ease of use. Firstly, camera captures the image and focuses on the eye in the image using OpenCV code for pupil detection. This results the center position of the human eye (pupil). Then the center position of the pupil is taken as a reference and based on that the human or the user will control the cursor by moving left and right [6-9].

This paper organization is described as follows. Section II describes existing solutions to find the cursor movement using some 3D models. In Section III we present how cursor is working based only on Eyeball movement using OpenCV methodology. In Section IV how the cursor is moving using eyeball with example with the better solutions. And the Conclusion part are presented in section V.

II. RELATED WORK

The basic actions of a mouse are mouse click and mouse movement. The advance technology replaces this mouse movement by eye motion with the help of an OpenCV. The mouse button click is implemented by any of the facial expressions such as blinking eyes, opening mouth and head movement. This model introduces a novel camera mouse driven by 3D model based bias face tracking technique. In personal computer(PC) due to the standard configuration it achieves human machine interaction through faster visual face tracking and provides a feasible solution to hand-free control. The face tracker used here is based on 3D model to control the mouse and carry out mouse operations.

Gaze estimation can be used in Head-mounted display (HMD) environments since they can afford important natural computer interface cues. This new gaze estimation is based on 3D analysis of human eye. There are various commercial products which use gaze detection technology. In this method, the user has to point only one point for calibration it will then estimate the gaze points. The facial features such as eyes and nose tip are recognized and tracked to avoid the traditional mouse movements with the human face for human interaction with the computer. This method can be applied to face scales in a wide range.

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978-1-7281-4988-2/20/$31.00 ©2020 IEEE

Six-Segmented Rectangular (SSR) filter and support vector machine are used for fast extraction of face candidates and face verification respectively. This comprises of our basic strategy for detection. Using JAVA(J2ME) for face candidate detection, the scale adaptive face detection and tracking system are implemented to perform left/right mouse click events when the left/right eye blinks. Camera mouse has been used for disabled people to make an interaction with the computer. [1]

The camera mouse is used to change all roles of traditional mouse and keyboard actions. The proposed system can give all mouse click events and keyboard functions. In this method, the camera mouse system along with the timer acts as left click event and blinking as right click event. The real time eye-gaze estimation system is used for eye controlled mouse for assisting the disabled. This system based on the methodology in which a general low-resolution webcam is used, but detects the eyes and track gaze accurately in less expense and without specific equipment. PIR sensor is specifically used for the human movement detection. This paper introduces a novel camera mouse driven by visual face tracking based on a 3D mode. This camera has a standard configuration for PCs with increased computation speed and also providing feasible solution to hands free Control through visual face tracking. Human facial expressions can be classified as rigid motion and non rigid motions. The rigid motions are rotation and translation whereas the non-rigid motions are opening, closing and stretching of the mouth.

Firstly, we use a virtual eyeball model which is based on the 3D characteristics of the human eyeball. By using a camera and three collimated IR-LEDs secondly, we will be calculating the 3D position of virtual eyeball and gaze vector [2]. Thirdly the calculation of 3D eye position and gaze position on a HMD monitor is allowed. This used simplified complex 3D converting calculations that have three reference frames (the camera, the monitor and the eye reference frames). Fourth, based on kappa compensation, a simple user-dependent calibration method was proposed by gazing at one position.

In our work, we are trying to compensate the need of people who have hand disabilities and could not be able to use computer resources without other individual's help. Our application mainly uses facial features to interact with the computer hence there will be no need of hands to operate the mouse [3].

Paralysis is a special case, in which the loss of muscle functions in part of your body. It happens when something goes wrong with the way messages pass between your brain and muscles. When such a thing happens, the person's ability to control movement is limited to the muscles around the eyes [4]. Blinking and movement of eyes is the only way of communication for them. To such communication defects the assistance given is often intrusive that is it requires a special hardware or a device. The alternate way for interfacing is through a non-intrusive communication system such as Eye Keys which works without special lightning. The eye direction is detected if the person looks at the camera, which can be used to control various applications [5].

III. Proposed Work

The proposed system uses Raspberry Pi board of version 3, which is attached with the Monitor, PIR Sensor, and Camera. These materials are attached by USB adaptors. Raspberry plays a vital role in the working module that keeps the eye movement with sensors. Raspberry pi uses SD card, to install raspbian is along with programming codes. PIR sensor also used for detecting human movement.

A. Face Detection

The computer technology which is used for a variety of applications by identifying the human faces in digital images is called as face detection. The proposed method detects features from the face. A simple face tracking system was developed. Face images can be analyzed without ever requiring any interaction with the user/person. Facial recognition can be used as an important measure of tracking the attendance and time information. Human face provide facial information that can be used for many applications like emotion recognition and human computer interface. Local binary pattern algorithm can be used for feature extraction.3×3 pixel image can be taken from the web camera. Encoding operation can be performed pixel values and transformed in to binary value 0 or 1.The face image is divided into N blocks. The thresholding function is described below:

$$S(g_c, g_i) = \begin{cases} 1, if\ g_c \geq g_i \\ 0, if\ g_c < g_i \end{cases} \quad (1)$$

Weight values are calculated for every neighbour and calculate the LBP value.

B. Eye Region Detection

The exact position of the pupil is known by using vertical integral projection and horizontal projection. These projections divide the whole picture to homogenous subsets. The arbitrary threshold is used in the proposed method. The noise can be removed by using Gaussian filter. The strong pixel value is based on minimum gradient point. The lower threshold protects against splitting edges in the contrast region. Circular Hough transform is used for finding the inner and outer boundaries. Hough transform check all the edge points with center coordinates.

C. Eye Movement Classification

The different eye-motions are classified with the help of support vector machine classifier. The eye-movements are eye open, eye close, eyeball left and eyeball right are captured by web camera. SVM can analyze data and used for classification and regression analysis. SVM is a set of associated supervised learning functions used for classification and regression problems. In SVM, the multi class file is used. This PIR sensor is connected to the General Purpose I/O port of the raspbian board, it detects the eye pupil movement and hence makes the camera to start capturing the images. Sensor can cover the range up to 5cm.

Once when the sensor detects the movement of eye pupil the camera starts to capture the images and send it into the raspbian board through an USB cable. The camera used here is an USB web camera of affordable cost. Then the transferred image is processed and monitored out. The function of the SD card is to store the Raspbian Jessie operating system module and it stores the program in it. The Raspberry Pi board is activated using Python programming language. The SD card capacity is up to 8GB.

The monitor input is got from the HDMI port of the raspberry board. HDMI is a High Definition Multimedia Interface port which is used to monitor the uncompressed video data. The HDMI converts digital image signal into analog signal and gives it to the monitor. Camera is used to capture the movement of eye. The center portion of the eye as well as the position of the people is identified for getting the various movements of eye. The process is implemented using Raspberry Pi. In Fig. 1 shows that the pupil reference has the coordinates of (x, y). Raspberry pi will be combining with USB Camera. Raspberry pi will be use SD card, then the install raspbian OS and Opencv on raspberry pi. First image will be capture by USB Camera. Focus on eye in image and detect the center position of pupil by Opencv code.

Support vector machine algorithm is used for classification. Eye image is denoted as a vector I which represents the pixel values. Training images are divided into two sets. The task of SVM is to determine the new data belongs to either positive set or negative set. Principle component analyses are applied to the training data and reduce the dimensionality of data.

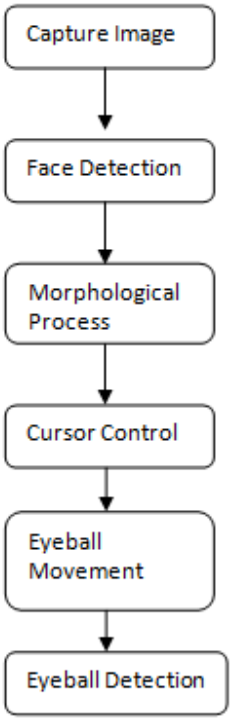

Fig. 1. Flow of Proposed Work

IV. PERFORMANCE ANALYSIS

After initiating the OS the operation starts. At first PIR sensor is used to detect the presence of individual in front of system. If the person is detected then camera will ON, where image will be captured by USB Camera. Focus on eye in image is shown in Fig. 2. Now the center position of pupil is detected in OpenCV. Take the exact position of pupil as reference, and then the next the different value of X, Y coordinates will be set for accurate command.

Fig. 2. Detection of Eye

$$d = \frac{max\{||L-L'||,||R-R}{L-R} \quad (2)$$

Detection error is the one of the parameter to evaluate the accuracy of proposed work. Images can be collected from the BioID database. The proposed method achieves better accuracy than existing methods. The following Fig. 3 shows the efficiency at different error levels.

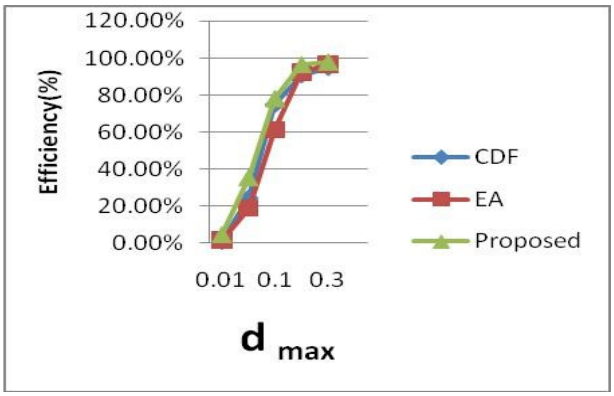

Fig. 3. Efficiency Analysis

V. Conclusion

From the process implemented it is cleared that the cursor can be controlled by the eyeball movement i.e., without using hands on the computers. This will be helpful for the people having disability in using the physical parts of the computers to control the cursor points. Because the cursor points can be operated by moving the eyeballs. Without the help of others disabled people can use the computers. This technology can be enhanced in the future by inventing more techniques like clicking events as well as to do all the mouse movements and also for human interface systems using eye blinks. Technology also extended to the eyeball movement and eye blinking to get the efficient and accurate movement.

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