Human Computer Interface System for Disable People using Eye Movement

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Abstract - *Eye tracking technology has become one of the most popular techniques within the human and computer interaction (HCI) this is very important for the people who have difficulty with speech and movement disabilities, especially for the paralyzed and amputees person. In this article we use openCV, python as our main tool. Using this we built an software such that the system locates users face and eye with help of the facial landmark predictor algorithm. With the landmark co-ordinates we perform the cursor movement and by providing an threshold value for the eye aspect ratio we perform the clicking event of the mouse.*

Key Words: Python, OpenCV, Eye detection, webcam, threshold value, Facial Landmarks.

1. INTRODUCTION

Personal computers were initially used for solving mathematical problems and word processing. In recent years, however, computers have become necessary for every aspect of our daily activities. Since the invention of the computer in the middle of the last century there has been the need for interface for users [1]. In the beginning, experts used teletype to ensure interfacing with the computers. Due to the tremendous progress in communication and computer networking in last few decades, working with a computer has become a normal activity of a layman, including physically and mentally impaired. Mouse is a functional and mechanical input device of a computer and is less useful for severely handicapped or paralyzed; also after nearly 70 years of its invention, there has been no greater improvement or innovation in this hand held instrument. Also, repetitive movement of the hand for mouse control will cause physical fatigue and the blood circulation to the bones, joints, muscles, tendons and ligaments will considerably reduce causing stiffness, pain, posture related problems and also Musculoskeletal problems [2]. Many researchers have tried to develop methods to help the disabled to interact with computers such as limbus, pupil and eye/eyelid tracking [3-4], contact lens method, corneal, pupil reflection relationship [5] and head movement measurement [6]. These methods require the use of attachments and electrodes to the head, which makes them impractical. Other high end techniques [7] that are based on infrared tracking of the eye movements to control. The proposed method uses implementing the movement of the iris to facilitate the input provided by the mouse to the computer. The HCI proposed in this paper is a custom developed low cost and efficient system to achieve fast and accurate detection of eyes, eye blinks and tracking of eyes and iris with unconstrained background. The only hardware that is required is a PC or laptop along with a webcam, which makes it practical and feasible. By taking consecutive snaps of the user from the camera, the program is designed to process these frames individually at very high speed of processing and compare the iris shift in each frame with respect to the initial frame. The frame undergoes several stages of processing before the eyes can be tracked. After obtaining the processed image, the iris shift is calculated and the program prompts the cursor on the screen to move to the respective location.

2. METHODOLOGY

The proposed system initially captures the images with help of an webcam that is internal or external webcam. We consider the images as frame and we pre-process it to our convenient, pre-processing performs frame resizing and conversion of the RGB image to the Gray scale image. The Face and eye detection is done by use of the Facial landmark detector and predictor which provides the landmarks for the face and parts of face. We further collect and use only the co-ordinates of the pair of eyes for this process. Then we track the eye and detect the movement of the eye for each frame. By using the movement of the eye the movement of the cursor also takes place. The clicking action is done by providing an threshold ratio which is compared with the ratio of the movement of the eye after which we perform the double and right click of the mouse. Fig.1. shows the block diagram of the proposed system.

3. IMPLEMENTATION

The implementation was carried out with help of the python language and the python tool and openCV-python. The algorithm for controlling the cursor by the eye iris movement was achieved through the following steps.

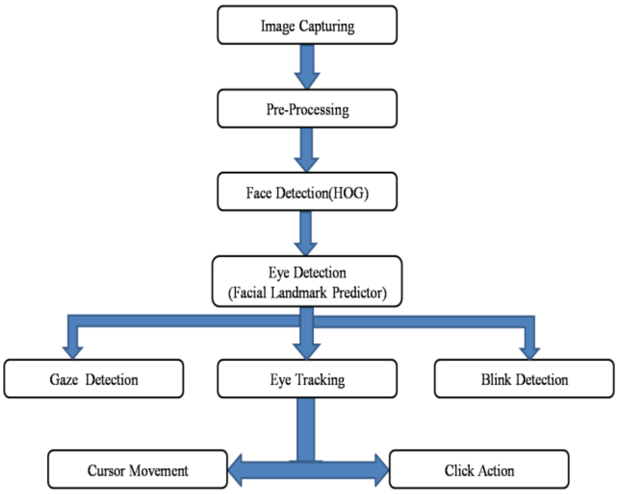

Fig -1: Block diagram of Proposed System.

Cursor Movement

The Fig 2 shows the flowchart of the cursor movement under the proposed system. Initially the process starts with the image capturing from the video stream. This image is then considered as the frame and pre-processing of the frame is carried out. Pre processing is made to resize the image to the appropriate size and also to convert the RGB image to Grayscale image format for further use. And with the help of HOG based and facial landmark predictor we locate the face and eye landmarks and co-ordinates, which provide 68 landmarks for the face with the face parts. By use the co-ordinates and by calculating the midpoints of the frame and the computer we achieve the movement of the cursor.

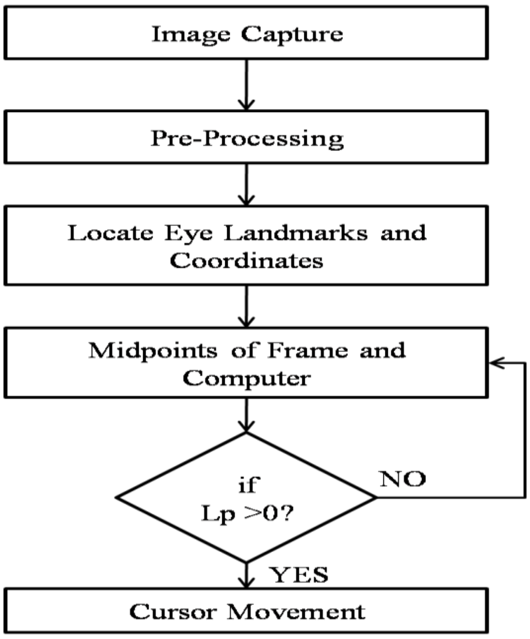

Fig -2: Flowchart for Cursor Movement

Click Action

The Following Fig.3 Shows the flowchart of clicking action of the proposed system. Once the move of the cursor takes place it keeps moving as loop throughout the process. We set a threshold eye aspect ratio as 0.23 for the click action. Once the eye aspect ratio of the left eye is lesser than the threshold eye aspect ratio the system performs The "Double Click" event as same as the normal mouse, and also when the eye aspect ratio of the right eye is lesser than the threshold eye aspect ratio the system performs the "Right Click" event as same as the normal mouse.

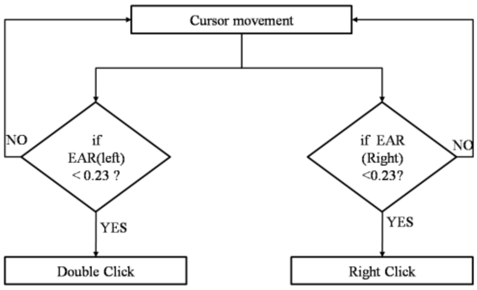

Fig -3: Flowchart for Cursor Movement

4. RESULTS

The results of different stages of real time implementation of the proposed HCI system have been provided in the following figures. Fig 4 shows the indication of the detected eye pairs with a green line enclosed over the detected eyes. We can also observe that there is an indication shown the image as "RIGHT CLICK PRESSED!" which is because of the right eye aspect ratio is less than the threshold eye aspect ratio and eye aspect ratio of the left eye is less than the threshold eye as ratio and the Indication "BUTTON PRESSED" that states the double click action of the mouse.

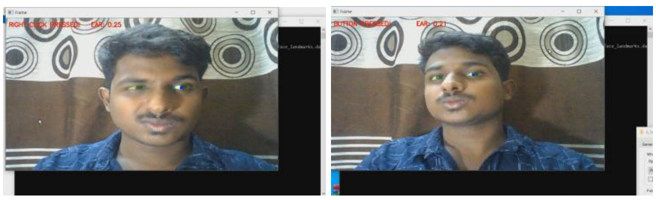

Fig -4: Indication of Eye Detection

Cursor moves in the upward direction, when the user is looking up, as shown in Fig 5, this way the cursor could be moved according to the wish of the user. This movement relates to the cursor movement and the action is followed and can be seen as shown below. The cursor movements of UP and DOWN are shown in Fig.5.

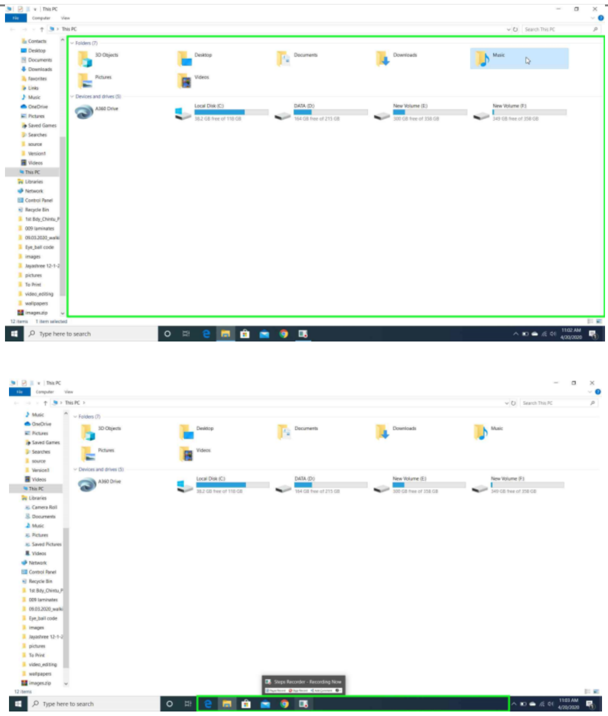

Fig-5: Cursor Movement Up-Down

The cursor movement is checked for the right direction. The user when she looks to the right, makes the cursor move to the right and left when she looks to the left direction in the white implementation panel too as shown in Fig 6. The shift of the cursor movement can be viewed real time and the video of the person is shown simultaneously, so that it could be relatable.

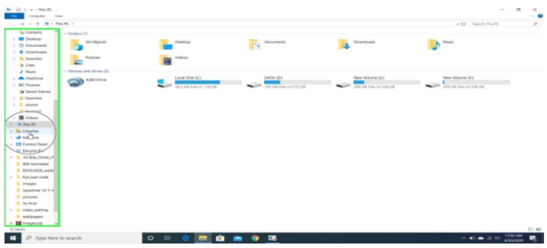

Fig-6: Cursor Movement left

The result of the movement can be tabulated as shown in Table 1 &2.

Distance from the computer	Time to reach an Icon and Click it (in Seconds)		
	First Trial	Second Trail	Average Time
12 inches	1.6	1.2	1.4
24 inches	1.9	1.8	1.85
36 inches	2.4	2.2	2.3

TABLE 1: Data and result for Multiple Distance

Angle of the Face	Iris Detection (Y/N)	Cursor manipulation (Y/N)	Time to Reach and Click an Icon(in Seconds)
30^0	Y	Y	2.8
45^0	Y	Y	2
90^0	Y	Y	1.4

TABLE 2: Data and result for Multiple Angle

Table 1 shows the time taken by the eye based mouse to reach an icon of interest and to click on the particular icon for three different distances of the human eye away from the webcam that is capturing the image of the eye. With help of few trials the average time that an eye based mouse takes to reach an icon is given below. Table 2 shows whether the eyes can be detected with face moved. And from the results we can see that the eyes can be detected with faced moved over a degree of angle and also the cursor movement takes place with the average time to reach an icon and click.

5. CONCLUSION

In this thesis, an interaction with the computer is done with help of an eye. It consists of a very simple initialization phase during which the eyes of the user are precisely detected. The detected eye pair is tracked during the movement of the user. The user's eye gaze are classified as left/right eye gaze controlled clicks and also as single right click or double click system. And the system was tested under various conditions and it is found that the detection is faster and accurate when the user is at a distance between one or two feet from the camera. The performance of the system is acceptable even under arbitrary backgrounds. It is also able to detect the eyes of the user wearing glasses, provided the glare from the computer screen is subdued. The tracker is able to tolerate about 30 to 45 degree of head turn in either direction. The effect of illumination variations, surrounding light environment, intrinsic problems such as calibration, users with glasses and head motion by the users are some of the concerns that need to be taken care.

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