HCI: Performing Mouse Operations Using Eyes

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Abstract- *Human Computer Interface and automation is one of the prime demands of today's age. The contribution of this new technology a type of rectangular feature for face detection is represented in a 2*3 matrix form. With this the processing time which includes capturing image, tracking image i.e. extracting eye and nose feature, setting various reference points, calculating distance between reference points, becomes significantly very short. This technology is used for an application that it is capable of swapping mouse with human face for interaction with PC. Facial features such as nose tip, eyes are traced and tracked to use their movements for performing mouse events. Co-ordinates of the nose tip in the video feed are interpreted to develop co-ordinates of the mouse on screen. The left/right blink control left/right events for click. The external device will be webcam for the video stream. Our proposed system will enable the physically disabled people to control PC operations through facial expressions which will act as mouse. By using six segmented rectangular filter and face verification through Support Vector Machine, the face structure of the user can be quickly recognized. Only the essential part of the image is been taken into consideration such as the six segments of the face with the help of the motion cue. The image of user's face will be captured and tracked after every interval of 30sec. System automatically detects the users eye blinks and accurately measures their durations. Long blinks triggers mouse click, while short blinks are ignored.*

Keywords- Face Detection, Face Tracking, Six Segmented Rectangular Filter, Support Vector Machine.

I. INTRODUCTION

From the last few years high technology has become progressed, and it is less expensive. Due to the availability of high speed processors and inexpensive webcams, many people have become interested in real-time applications that involve image processing. The current computer technologies has enhanced various applications in human-computer interface. Face detection is a part of this field, which can be applied in various applications such as in robotic, security system, drivers, monitor, image processing, and video coding system.

One of the promising fields in artificial intelligence is HCI.HCI aims to use human features like face and hands to interact with the computer. One way to achieve that is to capture the desired feature through a webcam and monitor its action in order to translate it to some events that communicate with the computer.

Since human face is a dynamic object and has a high degree of variability, we propose the method combine feature-based and image-based approach to detect the point between the eyes by using Six-Segmented Rectangular filter. The coordinates and movement of the nose tip in the live video feed are translated to become the coordinates and movement of the mouse pointer on the user's screen. The left/right eye blinks fire left/right mouse click events. The only external device that we needs is a webcam that feeds the program with the video stream.

In our work we were trying to make such a application which will help the people who have hands disabilities that prevent them from using the mouse by designing an application that uses face parts to interact with the computer.

In today's technological world, mouse plays vital role in many real time applications that involves Graphical User Interface. People who have hands disabilities prevent them from using the mouse and thus deprive them to use computer conveniently.

The system aims to present an such a software which is able to replace the usual mouse with the human face as a new way to interact with the computer. With the availability of high speed processors and inexpensive webcams, more and more people have become interested in real-time applications which involves image processing. Different detection techniques will be applied where the goal will be to achieve more accurate results with less processing time.

II. PREVIOUS WORK

For severely paralyzed persons who retain control of the extraocular muscles, two main groups of human–computer interfaces are most suitable: brain–computer interfaces (BCI) and systems controlled by gaze [1] or eye-blinks. A brain–computer interface is a system that allows handling computer programs or applications by measuring and interpreting electrical brain activity. There is no need of any muscle movements are required. Such interfaces enable to operate virtual keyboards [2], manage environmental control systems, use editors, browsers or make physical movements [3]. Brain–computer interfaces hold great promise for people with severe physical impairments; however, their main drawbacks are intrusiveness and need for special EEG recording hardware.

1) EYE DETECTION APPROACHES

Following are the various eye detection approaches:

1.1. Regression approach

It helps to minimize distance between the predicted and actual position of eye. Simply by understanding the functional mapping from the input image to eye positions.

1.2. Bayesian approach

From this approach we understand eye appearance and non-eye appearance. Use Baye's principle to build a "probability of eye". Produces output for patches around each pixel of the input image, from which a prediction will be extracted.

1.3. Discriminative approach

Treats the problem as one of classification. A classifier is trained to produce positive output for patches around the eye and negative elsewhere.

2) EYE TRACKING TECHNIQUES

There is no universal technique to track the movement of the eyes. In any study, the selection of the technique rests with the actual demands of the application. During the analysis phase of this research, three techniques were analyzed; the Limbus tracking, Pupil tracking, and Electrooculography. Every technique has its own robust points and disadvantages. [9]

2.1. Limbus Tracking

Limbus Tracking explains a way of tracking the eye using the limbus. The limbus is the boundary between the white sclera of the eye and the darker iris. As the sclera is white and the iris is darker, this boundary can easily be visually detected as well as tracked. This technique is based on the position and shape of the limbus relative to the head, therefore the head must be kept quite still or the apparatus must be fixed to the user's head. This technique is negatively affected by the eyelid often concealing all or part of the limbus. This makes its uses limited to horizontal tracking. Usually this technique does not involve the use of infra red light.

2.2. Pupil tracking

Pupil tracking is a technique of gaze detection that is commonly used often in conjunction with different forms of tracking. There are several reasons for this; however the main advantage is the notion of the "bright spot". Like the situation associated with red eye when taking flash photographs at night, infrared can used in pupil detection to form a high intensity bright spot that is easy to find with image processing. This bright spot occurs when infrared is reflected off the back of the pupil and magnified by the lens. The main advantage of pupil tracking is that as the border of the pupil is sharper than the limbus, a higher resolution is achievable. Also, as the pupil is never really covered by the eyelid, x-y tracking is more feasible as compared to Limbus tracking. The disadvantage is that the difference in contrast is lower between the pupil and iris than between the iris and sclera-thus making the border detection more difficult.

2.3. Electro oculography

Electro oculography is based on electrodes attached to the human skin. Due to the higher metabolic rate at the retina compared to the cornea, the eye maintains a constant voltage with respect to the retina. This can be approximately aligned with the optical axis. Voltage rotates with the direction of gaze and can be measured by surface electrodes placed on the skin around the eyes. This technique is easily mounted elsewhere other than directly in front of the person as compared to other techniques. Electrical skin potential tracking is often used in medicine and practice to diagnose certain conditions. For example, EOG is employed to diagnose sixth nerve palsy. From their analysis it can be seen that while a clinical orthotic examination is still the best technique of diagnosis. Electrooculography provides a suitable replacement within the follow-up stage of treatment programs. While these uses are beneficial, the utilization of electrodes makes this technique of gaze tracking unsuitable for use in everyday applications.

III. PROPOSED SYSTEM

A. Goal of the system

1. Hands - free computing
2. Facilitating the handicapped in using the computer
3. Controlling the mouse pointer through eye movement
4. Eye based human computer interaction provides real time

eye tracking and eye-gaze estimation

B. OBJECTIVES OF THE SYSTEM:

1. Easy interaction with computer without using mouse
2. Limitation of stationary head is eliminated.
3. Pointer of the mouse will move on screen where the user will be looking & the clicks will be performed by blinking.

C. FLOW OF USING THE APPLICATION

1) Face Detection

In the recent few years very large amount of research being carried out in the field of face detection. Face detection is a vast research in the computer world.

Face detection techniques are classified into two categories: Feature based approach and Image based approach [1].

i. Feature Based Approach

In Feature Based Approach system find the facial features and verify their performance by examining locations and distance from each other. Feature based approach can achieve high speed in face detection. Basically it is known for is pixel accuracy and speed.

ii. Image Based Approach

Image based approach scans the image of interest with a window that looks for faces at all the scales and locations. This category implies pattern recognition, and achieves it with simple method such as template matching.

FACE DETECTION ALGORITHM

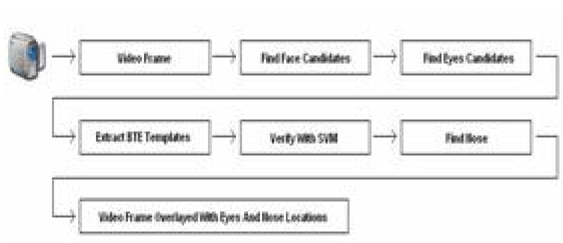

Figure 1. Algorithm for face detection

i. Finding Face Of Candidate

Find rectangle using SSR. The upper part of the rectangle is again split into two parts. One region consists of the eyebrows and the second region consists of the eyes. The eyebrow region is darker than the eye region due high amount of black region in the former. Once the lower rectangle is found which consists of only eyes then eyes can be detected using black regions. Once we have found the eyes and nose the tracking process starts.

ii. Motion Detection

To detect motion in a certain region system subtract the pixels in that region from the same pixels of the previous frame, and at a given location (x,y); if the absolute value of the subtraction was larger than a certain threshold, system consider a motion at that pixel.

iii. Eyes Tracking

If a left/right blink was detected, the tracking process of the left/right eye will be skipped and its location will be considered as the same one from the previous frame (because blink detection is applied only when the eye is still).

Eyes are tracked in a bit different way from tracking the nose tip and the BTE, because these features have a steady state while the eyes are not (e.g. opening, closing, and blinking).

To achieve better eyes tracking results system will be using the BTE (a steady feature that is well tracked) as reference point; at each frame after locating the BTE and the eyes, system calculate the relative positions of the eyes to the BTE; in the next frame after locating the BTE system assume that the eyes have kept their relative locations to it, so system place the eyes' ROIs at the same relative positions to the new BTE (of the current frame).

To find the eye's new template in the ROI we combined two methods: the first used template matching, the second searched in the ROI for the darkest 5*5 region (because the eye pupil is black), then system used the mean between the two found coordinates as the eye's new location.

The problem with the darkest region method was that it picked the eyebrow sometimes as the eye; here comes the eyebrow detection role where the eye's ROI is placed under the detected eyebrow line to avoid picking it as the eye.

Suppose that an eyebrow was picked as the new tracked eye, in the next frame the eyebrow detection region will be taken above the eye's ROI; in this case the region will contain only the forehead (because the region was taken above the false eye which is in fact the eyebrow).

So when eyebrow detection is run for the first time it will not find the eyebrow because thresholding the forehead will not give any results, so the eyebrow detection region will be lowered and the detection process will be rerun but this time it will find the eyebrow line, the eye's ROI will be placed beneath it, and the eye tracking process will find the correct eye again.

2) Eye-blink detection system

Vision-based eye-blink monitoring systems have many possible applications, like fatigue monitoring, human–computer interfacing and lie detection. No matter what the purpose of the system is, the developed algorithm must be reliable, stable and work in real time in varying lighting conditions. The proposed vision-based system for voluntary eyeblink detection is built from off-the-shelf components: a consumer-grade PC or a laptop and a medium quality webcam. Face images of small resolution (320 9 240 pixels) are processed with the speed of approximately 28fps. The eye-blink detection algorithm consists of four major steps (Fig. 3): (1) face detection, (2) eye-region extraction, (3) eye-blink detection and (4) eye-blink classification. Face detection is implemented by means of Haar-like features and a cascade of boosted tree classifiers. Eye localization is based on certain geometrical dependencies known for human face. Eye-blink detection is performed using the template matching technique. All the steps of the algorithm are described in more details in Sects. 5.2.1–5.2.3. The algorithm allows eye-blink detection, estimation of eye-blink duration and, on this basis, classification
of the eye-blinks as spontaneous or voluntary.

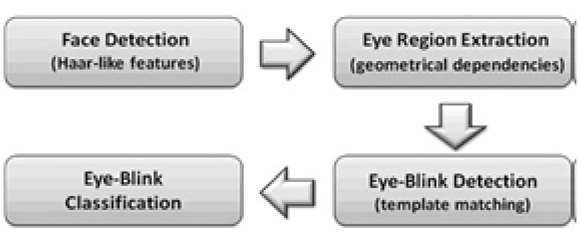

Fig. 2 Scheme of the proposed algorithm for eye-blink detection

2.1Eye-region extraction

The next step of the algorithm is eye-region localization in an image. The position of the eyes in the face image is found on the basis of certain geometrical dependencies known for the human face. The traditional rules of proportion show the face divided into six equal squares, two by three [7]. According to these rules, the eyes are located about 0.4 of the way from the top of the head to the eyes. The image of the extracted eye region is further preprocessed for performing eye-blink detection. The located eye region is extracted from the face image and used as a template for further eye tracking by means of template matching. The extraction of the eye region is performed only at the initialization of the system and in cases when the face detection procedure is repeated.

2.2 Eye-blink detection

The detected eyes are tracked using a normalized cross correlation method (1). The template image of the user's eyes is automatically acquired during the initialization of the system.

Where,

R correlation coefficient, T template image, I original image, x, y pixel coordinates. The correlation coefficient is a measure of the resemblance of the current eye image to the saved template of the opened eye (Fig. 3). Therefore, it can be regarded as the measure of the openness of the eye.

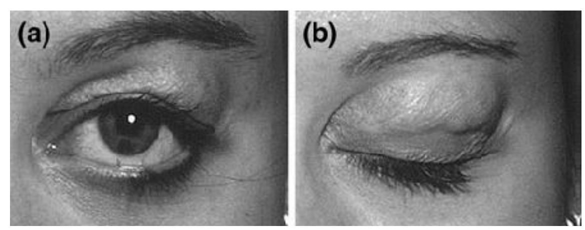

Fig. 3 Example eye images used as templates

2.3 Eye-blink classification

The change of the correlation coefficient in time is analyzed in order to detect the voluntary eye-blinks of duration larger than 250 ms. If the value of the coefficient is lower than the predefined threshold value TL for any two consecutive frames, the on-set of the eye-blink is detected. The off-set of the eye-blink is found if the value of the correlation coefficient is greater than the threshold value TH. The values of the thresholds TL and TH were determined experimentally. If the duration of a detected eye-blink is longer than 250 ms and shorter than 2 s, then such blink is regarded as a voluntary ''control'' one. System apply blink detection in the eye's ROI before finding the eye's new exact location. The blink detection process is run only if the eye is not moving (system consider the eye not moving if it didn't change its location in the past two frames), because when a person uses the mouse and wants to click, he moves the pointer to the desired location, stops, and then clicks; so basically the same for using the face: the user moves the pointer with the tip of the nose, stops, then blinks.

To detect a blink system apply motion detection in the eye's ROI; if the number of motion pixels in the ROI is larger than a certain threshold system consider that a blink was detected, because if the eye is still, and system is detecting a motion in the eye's ROI, that means that the eyelid is moving which means a blink.

In order to avoid multiple blinks detection while they are a single blink (because motion pixels will appear while the eye is closing and reopening), the user can set the blink's length, so all blinks which are detected in the period of the first detected blink are omitted. Sometimes the person blinks involuntary, but when he does he blinks with both the right and left eyes; so if system detected left and right blinks at the same time (or in the duration of one of them); system discard these blinks and consider them involuntary.

3) Six Segmented Rectangular Filter

We propose a real-time face detection algorithm using Six-Segmented Rectangular (SSR) filter, distance information, and template matching technique. Between-the-Eyes is selected as face representative in our detection because its characteristic is common to most people and is easily seen for a wide range of face orientation. Firstly, we scan a certain size of rectangle divided into six segments throughout the face image. Then their bright-dark relations are tested if its center can be a candidate of Between-the-Eyes. Next, the distance information obtained from stereo camera and template matching is applied to detect the true Between-the-Eyes among candidates. At the beginning, a rectangle is scanned throughout the input image.

4) Between-The-Eye

SVM has been used to verify the BTE template. Each BTE is computed as: Extract 35 wide by 21 high templates, where the distance between the eyes is 23 pixels and they are located in the
8th row. The forehead and mouth regions are not used in the training templates to avoid the influence of different hair, moustaches and beard styles.

IV. ADVANTAGES

1. Simulate mouse functions-
2. User can control mouse events like left click, right click, double click etc by movement of eyes.
3. Eye based human computer interaction provide real time eye tracking and eye gaze estimation.

V. FUTURE SCOPE

1. System works efficiently with uniform background so overcome by high performance.
2. Eyes is not really stable so an algorithm can be written which allows computer to smooth out the eye jitter.
3. User can able to scroll through screen.
4. User can able to zoom in & zoom out through screen.

VI. CONCLUSION

System is boon for the disable people who are not able to use physical mouse properly. It will gives them a new way to interact with computer world. It opens a new era in computer technology. It is efficient in real time applications which give speed and accuracy of the system.

System have presented a method of detecting and tracking faces in video sequences in real time which is based on skin color detection. This method first compensates the light in image then selects the skin tone for getting the face candidates. Systems basic strategy for detection is fast training with a Six-Segmented Rectangular filters. System have evaluated algorithm on various images and face databases. The images have been taken in different positions and lighting conditions.

System is aimed to implement real time face detection using SSR filter and tracking system using for face candidate detection, a six-segmented rectangle filter is scanned over the entire input image. This approach is similar to the window - scanning technique often used in the image - based approach. However, once the bright - dark relations between the six segments indicate a face candidate, eye candidate and nose tip regions are searched in the manner of the feature - based approach. Then, based on the locations of a pair of eye candidates and nose tip, the scale, orientation and gray levels are normalized.

The glasses reflect light and cause bright spots that sometimes force our program to lose track of the eyes. For the detection and tracking to be accurate and robust the lighting conditions must be set so the light is frontal in a way that it will spread evenly on the face, because side light will cause false face detection and will affect eventually the tracking process.

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