

Natural Eye Computer Interaction

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Abstract: This paper proposes a new system which uses human eye for computer interaction. With the development in recent technologies, modern computing systems are becoming more and more powerful. Modern computers are capable of processing millions of instructions per second. In such a scenario, traditional input devices such as mouse or keyboard are relatively slow. This can be resolved by human interaction with the computers. With the innovation and development in technologies, sensors are capable of capturing positions and natural movement of human body. Due to this a new way for interacting with computers is enabled. Hence based on this concept, we propose a system, which is planned to be deployed as a rapid and hands-free communication system. The system uses eye gestures that are crucial in designing a powerful, intuitive, and ultimately helpful user interface. The system would be capable of capturing eyeball movements using live camera feed, wherein the eyeball tracking is responsible for controlling the cursor. The system processes the data from the camera feed, and calibrates the parameter interfaces in accordance to the user. The system then performs computer vision related algorithms to determine the location of the user's pupils and eyeballs so as to implement Natural eye-computer Interaction.

Keywords: Haar Cascade, Image Processing, Blob Detection, Edge Detection., Haar Classifiers, Center Point

1. Introduction :

Use of image processing is increased in today's modern world. The technology for measuring a user's visual line of gaze (where he or she is looking in space) and reporting it in real time has been improving, what is needed is appropriate interaction techniques that incorporate eye movements into the user-computer dialogue in a convenient and natural way. Because eye movements are so different from conventional computer inputs, our basic approach to designing interaction techniques has been, wherever possible, to obtain information from the natural movements

of the user's eye while viewing the display, rather than requiring the user to make specific trained eye movements to actuate the system.

While a large number of different techniques to track eye movements have been investigated in the past, three eye tracking techniques have emerged as the predominant ones and are widely used in research and commercial applications today, video based tracking is one of them. Video-based eye tracking relies on off-the-shelf components and video cameras and can therefore be used for developing eye-aware or attentive user interfaces that do not strictly require accurate point of gaze tracking.

A video-based eye tracking system can be either used in a remote or head-mounted configuration. A typical setup consists of a video camera that records the movements of the eye(s) and a computer that saves and analyses the gaze data. The frame rate and resolution of the video camera have a significant effect on the accuracy of tracking; a lowcost web camera cannot compete with a high-end camera with high-resolution and high sample rate.

2. Related Work :

Many researchers in the field of human computer interaction and robotics have tried to control the mouse events using various methods. Some of the methods are finger tip tracking mouse proposed by Erdem et al, he implemented clicking of mouse based on the movement of fingers of users on the screen respective to the cursor. Another one implemented by Chu-Feng Lien was almost similar to Erdem et al's system. Image density was taken into consideration for clicking of mouse when user hold the cursor at the spot for a short period of time. One system proposed by Sarita and Kiran Kumar Kaki was totally inspired by speech recognition. The movement of mouse was instantaneous as soon as the voice was commanded.

Our project was inspired by Shrunkhala Satish Wankhede's "Controlling Mouse Cursor Using Eye Movement" paper. They have used Regression approach, Bayesian approach and Discriminate

approach for eye detection. Instead we have used Haar Cascade Algorithm and Haar features with machine learning to detect eyes, face and nose. Based on position of nose, our cursor will take its position and with nose's movement respective. In our work, we have tried to control the mouse events by human eye and nose. To move the mouse cursor nose movements are used and for the clicking event eye blinking is used. The real time video is captured using web camera. The captured video is then converted into 20-30 frames per second. Now, in order to get correct trimmed images the person need to sit absolutely still which is uncomfortable and impossible. So, to get rid of this problem Haar-Cascade algorithm is used. In order to obtain Edges so as to obtain an image that suffices the differentiating condition for eyeball and the rest of the eye Edge Detection is applied. Also, in proposed system to obtain the eyeballs and their relative positioning with each other Blob Detection is used.

3.1 System Flow :

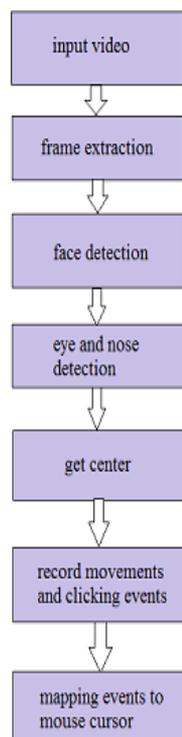


Fig. 1 System Flow

3.2 Capturing real time video

The sensor is required for capturing the movements by user. The web camera is used as sensor for tracking the movements. The frame rate and resolution of the video camera have a significant effect on the accuracy of tracking; a low-cost web camera cannot compete with a high-end camera with high-resolution and high sample rate.

cursor's movements will be implemented. Blinking of eyes is used for clicking events.

3. Proposed System :

- Web camera is used to record the real time video
- Video is converted into frames as per FPS (frame per second) according to the camera.
- Each frame is processed separately.

Each frame is processed individually from which the number of faces are detected. From that faces the first detected face is taken into consideration. The face is detected using haar-classifiers. This detected face is used for the further processing.

3.3 Eye and Nose Detection

The haar cascade algorithm is already trained for the eye and nose detection. Those xml files can be used to automatically detect the objects from the image. So we have used these xml files to detect the users eyes and nose from the face detected previously from the face detection phase. In haar cascade algorithm there are more facilities like the eyes with eyeglasses can also be detected.

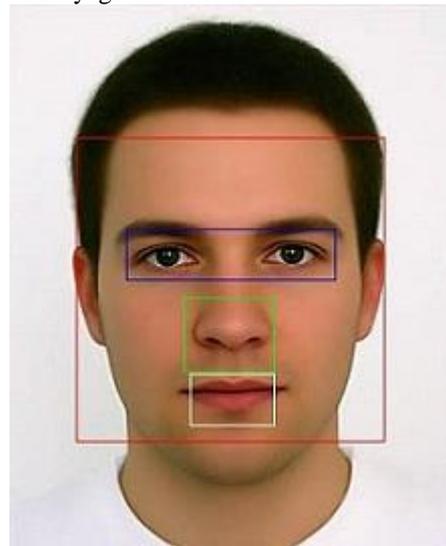


Fig.2 Eye and Nose detection

3.4 Getting the Center

To move the mouse pointer according to the movement of nose, there should be a specific point. From the movement of that point the movement of mouse can be controlled. This is achieved by finding the exact center of the nose. That center is calculated by the simple mathematical formula center the rectangle.

$$x = |x_2 - x_1| \quad \text{and} \quad y = |y_2 - y_1|$$

where,

(x , y) are the coordinates of the center of nose, (x_1 , y_1) and (x_2 , y_2) are the diagonal coordinates of rectangle.

3.5 Recording Movements and Clicking Events

The control action of the mouse is performed by taking the combination of movement of mouse and blinking of the eye. Movement of the mouse is nothing but the transformation of screen coordinates from old to new. The current coordinates of the mouse is the center point of the nose calculated in the previous phase. These coordinates are parameters to the function move which is the default function in JAVA to control the mouse movement.

Blinking of the eye is used for the clicking events. To recognize this, image is used which is of closed eyes. The comparison is performed between the current image and the image for closed eyes. According to the comparison the result will be displayed. The blinking of the eye and clicking event is associated in the following manner:

- Left eye blink represents the left click event
- Right eye blink represents the right click event
- Closing of both eyes represents the double click event

4. Results and Discussions:

Our testings of all mouse events such that left click, right click, double-click, dragging, and scrolling on Windows 7 and above, Quad Core Systems, 4GB memory, inbuilt WebCam (640x480 resolution, 15fps) showed that the mouse device is more feasible than video based mouse movements as there are a lot computations required to carry out the whole process. And this in turn can slow down the system and performance is degraded.

5. Problems and Drawbacks:

Since the system is based on the image captured through WebCam, there is possibility of detecting multiple faces. So one of the drawback is the user should be the only one in front of the camera. This can be solved by taking care of the number of persons appearing in the camera. The user should be the only one in front of the camera while operating the system.

The system might run slower on computer or pc having low computational power as more number are computations are performed in less time. The standard pc or laptop has got the optimum power to run the system. Another problem is if the resolution of the camera is too high then the system might run

slow. This drawback of the system can be resolved by reducing the resolution of the camera.

6. Conclusion :

We developed a system to control the mouse events using human eye and nose. It includes all mouse events left click, right click, double click and movement of cursor. The system is developed using JAVA programming language and computer vision for image processing. However, it's difficult to get stable results because of the variety of lighting.

The system has many applications in the field on computer gaming. It also can be used in computer graphics, prosthetic and bio medical instruments. The major application of the system is it can be used by the disabled ones which is the main motive of the proposed system. Most of the applications required additional hardware which makes it expensive. The proposed system is developed using only software which makes it much cheaper.

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