JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Human Computer Interaction Based Eye-Controlled Mouse

T Asha Latha, Assistant Professor, Anurag University
R. Pavan Kumar, V. Nagaraju, P. Rama Krishna
UG Students, Anurag University - Hyderabad

ABSTRACT:

Given today's sophisticated technologies, there is always room for advancement in the computing industry. As of right now, hands-free computing is in demand since it helps quadriplegics (people affected by paralysis of all four limbs). In this article, we suggest introducing a Human-Computer Interaction (HCI) system that is crucial for people with amputations and others who have trouble using their hands. The created system uses an eye-based interface to transform eye movements like blinking, staring, and squinting towards mouse cursor actions. Python, OpenCV, NumPy, and a few more software packages are needed for face recognition by this system, which intends to use a basic webcam. The HOG (Histogram of Oriented Gradients) feature, a linear classifier, and the sliding window method can all be used to create the face detector. There is no need for additional gear or sensors, and it is hands-free.

1. INTRODUCTION:

With today's technology, moving the cursor around the screen with the computer mouse or by moving the finger has become increasingly frequent. The technology tracks any mouse or finger movement and translates it to cursor movement. Certain people, known as "amputees," who are unable to use their arms will not be able to use the existing technology to use the mouse. So, the movement of the facial features can be translated to the cursor and the amputee will be able to move the cursor at will if their eyeball and facial features can be tracked and the direction in which the eye is looking at can be detected. An 'eye-tracking mouse' will be of a lot of use to an amputee.

1.1.Overview:

- The following actions or duties are carried out by our project:
- Opening the Mouth
- Right Eye Wink
- Left Eye Wink
- Squinting Eyes
- Head Movements (Pitch and Yaw)

The webcam must be accessed first because the project depends on identifying facial traits and mapping them to the cursor, which requires opening the webcam. The software must extract each frame from the video after opening the webcam. A frame will be used for processing every 1/30th of a second because the frame rate of the video is typically around 30 frames per second. Before the frame's features are recognized and mapped to the cursor, this frame goes through a number of steps. And as part of a loop, this operation runs continually for each frame.

Once the frame is extracted, the regions of the face need to be detected. Hence, the frames will undergo a set of image-processing functions to process the frame in a suitable way, so that it is easy for the program to detect the features such as eyes, mouth, nose, etc.

1.2. Objective:

Our project's goal is to make it simple for "amputees"—those without arms—to perform their daily tasks. With the aid of our project, quadriplegics or amputees (those who have all four limbs paralyzed) can use and operate the mouse using their facial features and eye movements.

This Project undertakes to develop a system that will only use a webcam to use human eyes and facial features as a pointing device for the computer system to provide a user-friendly human-computer interaction project. The objectives are outlined below:

- Face and Eyes Detection
- Eye Corners extraction
- Develop an algorithm to calculate point of gaze-based on eye features found

- Develop a GUI to show results
- Develop a simple Calibration technique

1.3. Scope of the Project:

The project is wide in scope. Our project the 'Human-Computer Interaction based eye-controlled mouse' is an application that will be very helpful to 'Amputees' in controlling the mouse by using justthe eye gestures and facial expressions. The benefits of using our project are as follows:

- Easier computer control,
- Help disabled & handicapped people to use computer
- Helpful in commercial interactive games and advertisements

2. PROBLEM STATEMENT:

In the current technology, moving the cursor and the screen using the computer mouse or a finger has been a fairly prevalent method. The technology tracks any mouse or finger movement and translates it to cursor movement. For an amputee, an HCI-based eye-tracking mouse will be quite helpful. The eye-tracking mouse is currently not widely accessible, and only a few companies have created and made this technology available. An IR sensor should be employed in our existing system to obtain an accurate image of the iris. And a gyroscope can be used to rotate the head, although this approach needs the right hardware. So in our project, instead ofusing only the eye gaze and actions to track the mouse, we will be using eye gestures along with facial expressions.

3. OVERVIEW OF THE SYSTEM:

3.1. Existing System:

In the age of modern technology, moving the cursor and the screen using the computer mouse or a finger has been a fairly frequent method. The technology tracks any mouse or finger movement and translates it to cursor movement. Certain people, known as "amputees," who are unable to use their arms will not be able to use the existing technology to use the mouse. As a result, if the movement of their eyeball can be recorded and the direction in which the eye is gazing can be detected, the movement of their eyeball may be translated to the cursor, allowing the amputee to move the cursor at will. An 'HCI-based eye-tracking mouse' will be of a lot of use to an amputee. Currently, the eye-tracking mouse is not available on a large scale, and only a few companies have developed this technology and have made it available. The following are some drawbacks of ExistingSystem.

- In the existing system, to get an accurate image of the iris an IR sensor should be used.
- And a gyroscope can be used for the orientation of the head but this method requires the appropriate hardware.
- So in our project, instead of using only the eye gaze and actions to track the mouse, we will beusing eye gestures along with facial expressions.

3.2. Proposed System:

The proposed system has the following actions.

- Opening the Mouth
- Right Eye Wink
- Left Eye Wink
- Squinting Eyes
- Head Movements (Pitch and Yaw)

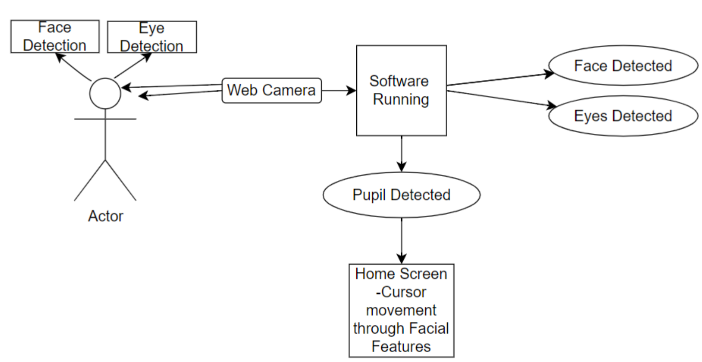
Since the project is based on detecting the features of the face and mapping them to the cursor, the webcam needs to be accessed first, which means that the webcam will be opened. Once the webcam is opened, the program needs to extract every frame from the video. This frame undergoes a set of processes before the features of the frame are detected and mapped to the cursor. And this process continuously takes place for every frame as a part of a loop. The advantages of proposed system are as follows.

- Hands-free mouse cursor control system.
- Facilitating the incapacitated.
- Mouse pointer control through eye movements and facial expressions.
- Simulating mouse functions, performing different mouse functions such as left click, rightclick, double click and so on using their eyes and facial features.

4. ARCHITECTURE:

In reference to computers, software or networks, the overall design of a computing system and the logical and physical interrelationships between its components. A system architecture is the conceptualmodel that defines the structure, behavior, and more views of a system. An architecture description isa formal description and representation of a system, organized in a way that supports reasoning aboutthe structures and behaviours of the system.

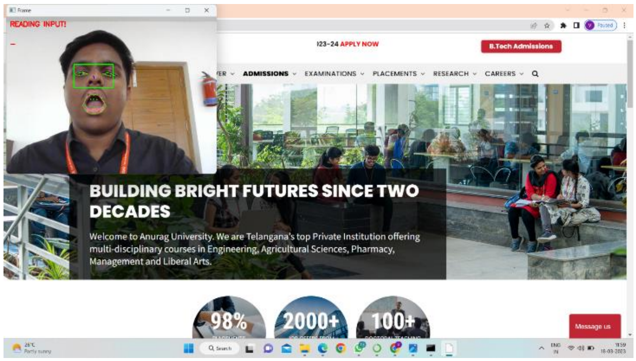
A system architecture can consist of system components and the sub-systems developed that will worktogether to implement the overall system. There have been efforts to formalize languages to describe system architecture, collectively these are called architecture description languages (ADLs).



SYSTEM ARCHITECTURE

5. RESULTS AND DISCUSSIONS:

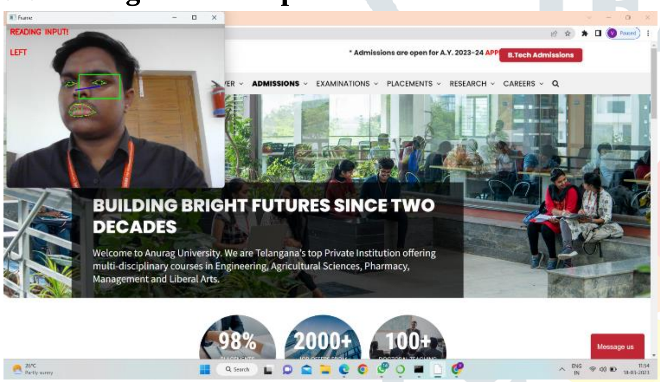
5.1.Activating the mouse – Reading Input



Activating the mouse-Reading Input

To 'yaw,' or expand his mouth vertically, the user must first increase the space between the matching 2D points of his mouth. When the ratio reaches a predetermined level, the system is enabled and the cursor can be moved. The algorithm uses this ratio to detect changes in distance.

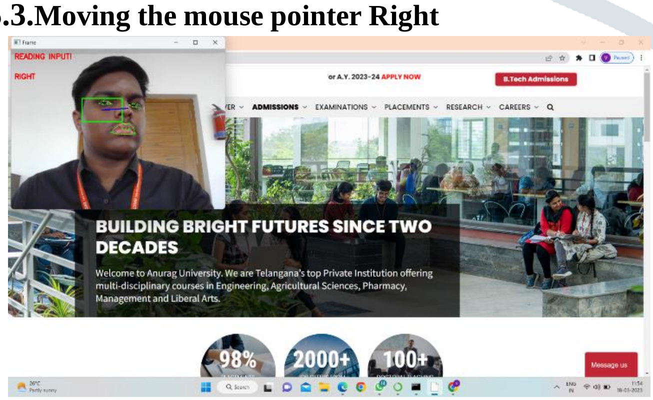
5.2. Moving the mouse pointer Left



Moving the mouse pointer left

To move the cursor in the desired direction, the user must point his nose in the direction of the top, bottom, left, or right of a rectangle that emerges. The pointer moves more quickly the farther the user is from the rectangle.

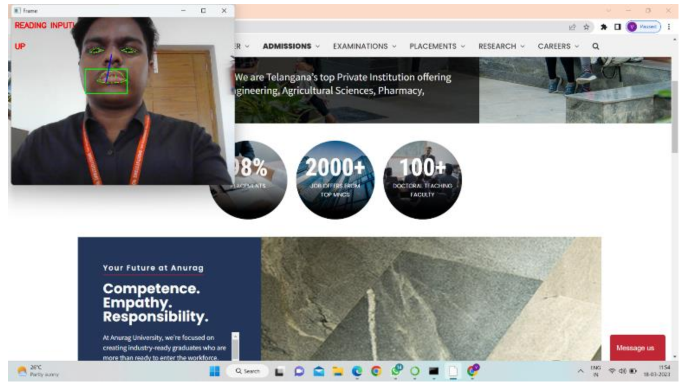
5.3.Moving the mouse pointer Right



Moving the mouse pointer Right

The pointer will move in the appropriate direction when the user points his nose towards the top, bottom, left, or right of an apparent rectangle. The pointer moves quicker the more he moves away from the rectangle.

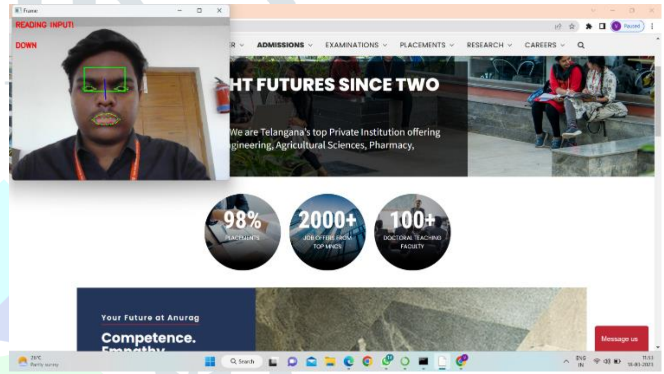
5.4. Moving the mouse pointer Up



Moving the mouse pointer Up

The cursor can be moved by pointing the user's nose in one of four directions: up, down, left, or right, depending on the shape of the rectangle that displays. The speed of the pointer movement increases as he moves further away from the rectangle.

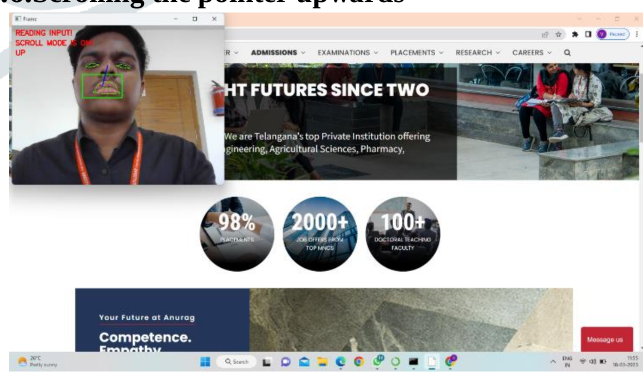
5.5.Moving the mouse pointer Down



Moving the mouse pointer Down

To move the cursor in the appropriate direction, the user must point his nose in the direction of the top, bottom, left, or right of a rectangle that emerges. The pointer moves more quickly the farther away the user is from the rectangle.

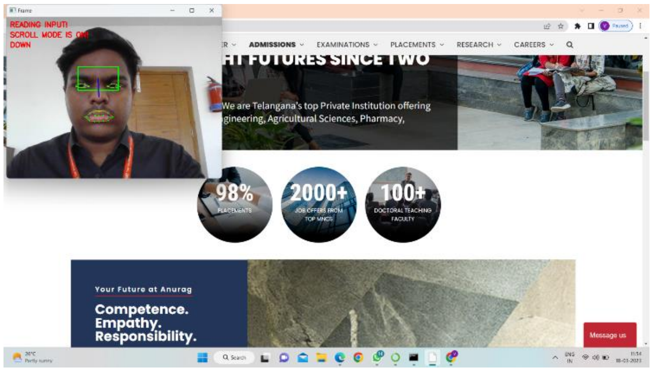
5.6.Scrolling the pointer upwards



Scrolling the pointer Upwards

The mouse can be scrolled up or down by the user. He must squint his eyes so that they are less than the required value for both eyes' aspect ratios. In this instance, the mouse scrolls instead of moving the cursor when the user's nose is outside the rectangle. He can scroll higher by moving his nose above the rectangle, or downwards by moving it below the rectangle.

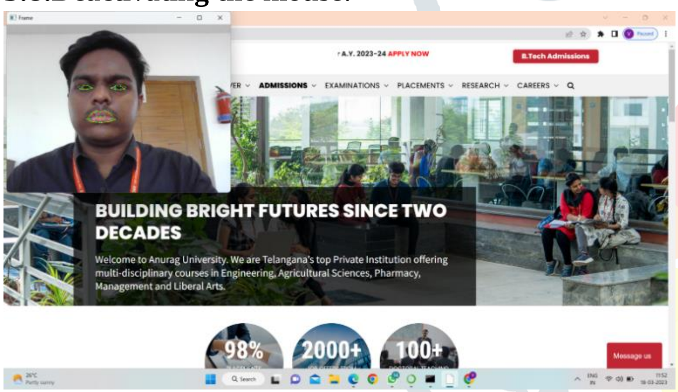
5.7. Scrolling the pointer Downwards



Scrolling the pointer Downwards

The user can scroll the mouse, either upwards or downwards. He needs to squint his eyes in such a way that the aspect ratio of both the eyes is less than the prescribed value. In this case, when the user places his nose outside the rectangle, the mouse performs scroll function, rather than moving the cursor. He can move his nose either above the rectangle to scroll upwards, or move it below the rectangle to scroll downwards.

5.8.Deactivating the mouse:



Deactivating the Mouse

To 'yaw,' or expand his mouth vertically, the user must first increase the space between the matching 2D points of his mouth. When the ratio reaches a predetermined level, the system is enabled, and the cursor can be moved. The algorithm uses this ratio to detect changes in distance. But, completing the 'yaw' function once again makes the mouse inactive.

6. CONCLUSION:

This work can be extended to improve the speed of the system by using better-trained models. Also, the system can be made more dynamic by making the change in the position of the cursor, proportionalto the amount of rotation of the user’s head, i.e., the user can decide, at what rate he wants the positionof the cursor to change. Also, future research work can be done on making the ratio more accurate, since the range of the values is the result of the aspect ratios, which are usually small. Hence, to makethe algorithm detect the actions more accurately, there can be some modifications in the formulae forthe aspect ratios used. Also, to make the process of detection of the face more easily, some image processing techniques can be used before the model detects the face and features of the face.

7. FUTURE ENHANCEMENTS:

In the future, a multimodal system, which enables computer operation without the use of a regular mouse and keyboard, may be a viable alternative for many people who are unable to use a standard computer mouse or keyboard due to physical limitations of their hands or arms. uses speech to issue control commands and head movements to move the cursor around the computer screen. The system is operated by combining automatic speech recognition with head tracking in cooperative multimodal action.

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