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Controlling Mouse Motions Using Eye Tracking Using Computer Vision

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***Abstract*— This paper introduces an algorithm to carry out the functions of a mouse by providing a hands-free interaction between humans and computers. It provides an alternative to the traditional mouse computer. By using different expressions of a face using computer vision and matching it with already stored expression and execute actions as per the move. This algorithm will help physically disabled people to perform the functions of a mouse using their face and eye movement. It allows them to left-click, right-click, scroll up and down, move the cursor up, down, left, right. The system has a very basic need like webcam, NumPy, dlib, and a few other basic libraries.**

Keywords—computer vision, human-computer interface;

I. INTRODUCTION

The advent of computers in 1938 has changed the way we live our lives today at ease. They have gone through rigorous changes. Initially, their task was to solve mathematical problems and word processing now they have traveled a long way to making a necessary space in our lives with its uses ranging from professional to personal such as browsing on the internet, connecting the world through social media, controlling large machines in factories using the right and timely operations. Computers are readily usable to persons who have hands to control mouse and keyboard and eyes to see what is on the monitor. Now even blind can use the computer using the text to speech option which pronounces the content on the screen. But people who do not have hands cannot use it due to their inability to control mouse and keyword operations. In today's competitive environment everybody needs to be equipped with different sets of skills so as get a job. Knowledge and usage of computers being a necessity nowadays. So this causes them to live a miserable life. They have to beg and do pitiful activities to keep their lives going. By introducing them to technology and make them computer compatible will create a ray of hope for them to learn and do some work to their livelihood. Several efforts are made by professionals to assist the disabled in providing them a tool to interact with the computers using signals such as electroencephalography (EEG) from the brain, facial muscle signals (EMG), and electrooculogram (EOG). Also, methods like limbus, pupil, and eye/eyelid tracking, contact lens method, corneal, pupil reflection relationship have also been implemented. These methods require the use of attachments and electrodes means some physical connection is needed to the head, which makes them impractical. The method described in this paper does not use any of this expensive equipment. Also, even physical connection has to be made with the user through any equipment. It just needs a computer with a webcam making it easy and cheap and uncomplicated method. By taking real-time images of the user the program is designed to evaluate these images and identify the type of action to be performed by taking a match against the previously stored expressions to identify the operation to be performed and take parameter if needed in case of moving the cursor the change in the relative position of eyes concerning the central position tells about the direction to move the cursor. The implementation of this method would open a wide range of options for people who don't have hands. It will enable them to go to school and learn through the computer with the mouse being controlled by their head movement. It would also give them job opportunities in the service to earn them a job.

II. METHODOLOGY

The algorithm starts to detect a face of a person using a face detection algorithm. After detecting the face, the position of eyes and mouth is captured for controlling the mouse functions such as left-click, right-click, and cursor movement. This method doesn't require any special hardware and sensors. It is a hands-free system that is useful for handicapped. First, we have to activate the mouse control mode by opening the mouth. For moving the mouse cursor left or right we simply have to move our head in the intended direction of movement of a cursor. For enabling the scroll mode, we have to squint our eyes into the camera and on initiation, it will show scroll mode is on. Now you can move your head up for scrolling the up and similarly down to scroll the page down.

III. IMPLEMENTATION

The method for mouse movement by pupil and mouth movement was achieved using the following process:-

A. Face Detection

To represent a clean and accurate image, the user should face parallel to the webcam position as represented in Fig. 1.

The image of the person is captured by webcam pre-installed in the system using OpenCV and processed using python. Fig. 2 shows the captured image using a webcam.

Dlib has a pre-trained dataset iBUG 300-W which has 68 coordinates that mapped to the face of a person. The facial detector detects key landmarks on the face of a person and tracks them. Fig. 3 shows 68 facial coordinates.

B. Eye Detection

For eye detection, we use Eye-Aspect-Ratio (EAR). It was used to observe if the person's eye is flickering or not in the video frame.
Each Eye is expressed as 6 coordinated (p1-p6), p1 is the coordinate of the left part of the eye and then p2-p6 is located accordingly when we travel in the clockwise direction as shown in (1).

$$EAR = \frac{(p2 - p6) + (p3 - p5)}{2(p1 - p4)}$$

p1-p6 *are points located on the eye*
p2-p6 and p3-p5 depicts the vertical distance between the eyes
p1-p4 depicts the horizontal distance between the eyes

Fig. 1 System set up for eye mouse

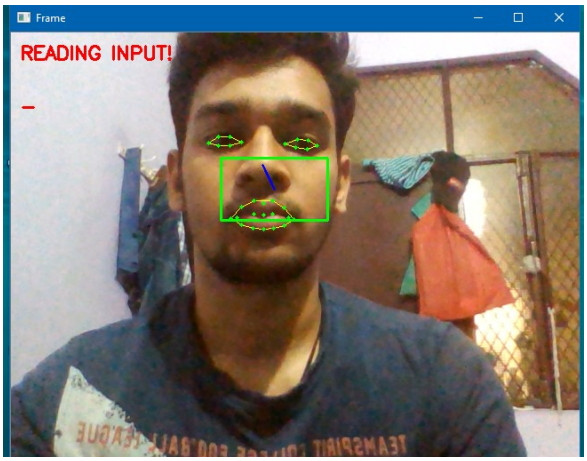


Fig. 2 Image captured using the webcam

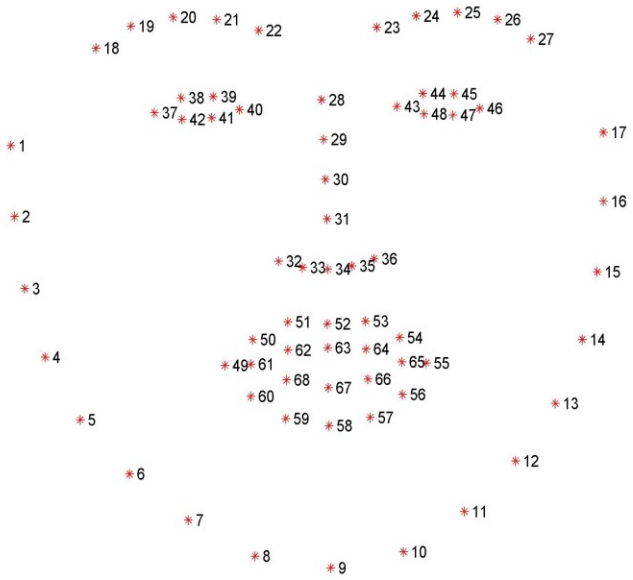


Fig. 3 68 Facial coordinate point

eye-aspect-ratio (EAR) is consistent until the time eye is open, but it tends to zero when a flickering is started as shown in Fig. 5.

C. Mouth Detection

Same as eye-aspect-ratio, we have mouth-aspect-ratio(MAR), which is used to identify whether the mouth is open or not as shown in Fig. 6

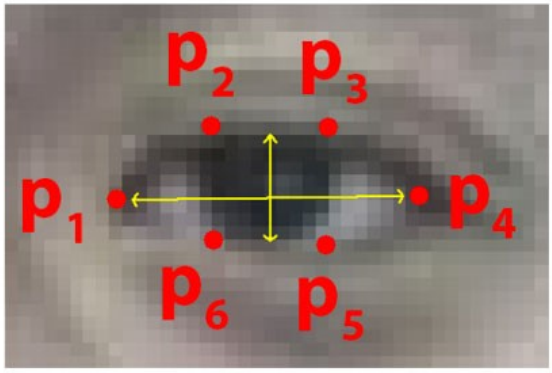


Fig. 4 The 6 facial landmark associated with eye

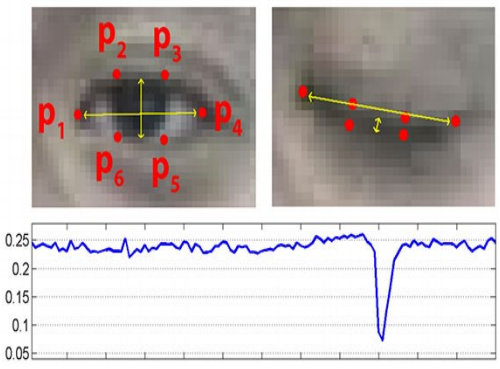
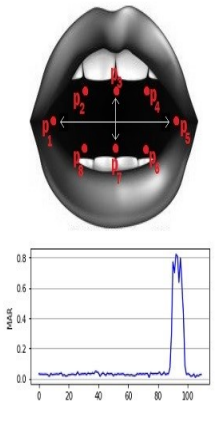


Fig. 5 Top-left: *Eye is open.* Top-right: *Eye is closed.* Bottom: *Plotting the Eye-Aspect-Ratio over time.*



$$MAR = \frac{\|p_2 - p_8\| + \|p_3 - p_7\| + \|p_4 - p_6\|}{2\|p_1 - p_5\|}$$

Fig. 6 Mouth-Aspect-Ratio

D. Algorithm

The algorithm used can be depicted by the flowchart shown in Fig. 7.

- The camera keeps looking for pictures at the rate of 30 frames per second. If it can detect a face then it checks whether the face control function is on or off.
- Then if it is enabled it captures frames for different instructions by the user through the movement of his face as per the directions given.
- If he wants to turn the scroll mode on he/she has to squint both eyes and then move his face up or down for scrolling.
- To simply move the cursor user will simply move his head.
- For click, he will squint one of his eyes as per the side of the mouse he wants to press.
- To disable the mouse control, he has to again open his mouse open.

E. Usage

The figure 8 explained the different modes and working of the algorithm. In this, we explained the action and their corresponding function we used in our algorithm.

- For activating/deactivate mouse control we have to open mouth continuously for some time.
- If the user blinks their left eye it will act as a left-click.
- If the user blinks their right eye it will act as a right-click.
- If the user squints his/her eye for some time it will activate/deactivate scrolling.
- Head will be used for cursor movements and scrolling up or down

IV. RESULTS AND DISCUSSION

After the implementation of the algorithm it was tested on a webpage and it showed correct results. The test started with the camera being turned on looking to detect a face. As soon it detects a face it marks the border of eyes and mouth to tell the user about the areas it will consider for an input.

First, we have to activate mouse control mode by opening mouth as shown in Fig 8 and it will show reading input. A rectangular box will be there to tell you about your movement

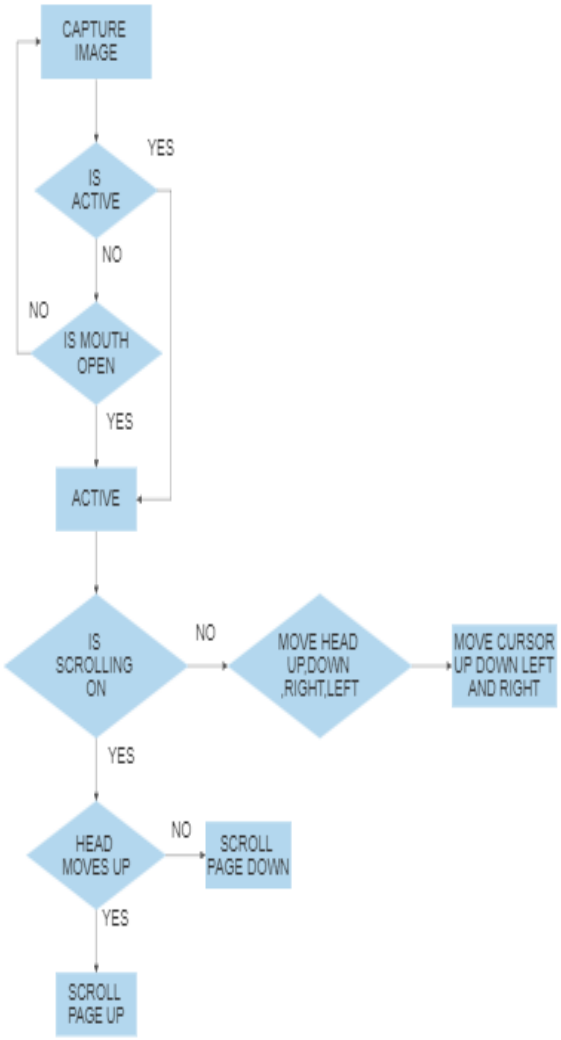


Fig. 7 Flowchart of the algorithm

from the initial position and will draw a line in the direction of movement which will tell about the length traveled from the epicenter.

For moving the mouse cursor left or right we simply have to move our head in the intended direction of movement of the cursor.

For turning the scroll mode on we have to squint our eyes into the camera and on initiation, it will show scroll mode is on. Now you can move your head up for scrolling the up and similarly down to scroll the page down.

For clicks, we have to blink the left eye and right eye for left-click and right-click respectively. Fig. 9 to Fig. 12 are shown for results.

- Fig. 9 depicts cursor movement towards the left direction when mouse control is activated by opening mouth for a certain time.

- Fig. 10 depicts cursor movement in the right direction when mouse control is activated by opening mouth for a certain time.
- Fig. 11 depicts scrolling function towards a downward direction when mouse control is activated by opening mouth for a certain time and scrolling mode is also activated by squinting eyes.
- Fig. 12 depicts scrolling function towards upward direction when mouse control is activated by opening mouth for a certain time and scrolling mode is also activated by squinting eyes.

V. CONCLUSION

A system that facilitates contactless control of mouse is developed and tested. It has an easy and wide application. Easy mouse cursor movement using face and switching between modes using eyes to enable or disable scrolling. Blinking to click. It has a wide range of applications. It can be used for physically disabled people in their education as this would empower them to type instead of writing without hand. This will lead to job opportunities for disabled people. It can be used in vehicles to observe the laziness of the driver by detecting the drowsiness symptoms like yawning. It can also be used in gaming and the Internet of Things domain.

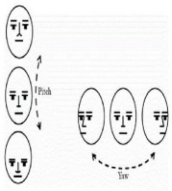
Action	Function
 Opening Mouth	Activate / Deactivate Mouse Control
 Right Eye Wink	Right Click
 Left Eye Wink	Left Click
 Squinting Eyes	Activate / Deactivate Scrolling
 Head Movements (Pitch and Yaw)	Scrolling / Cursor Movement

Fig. 8 Action and their respective functions

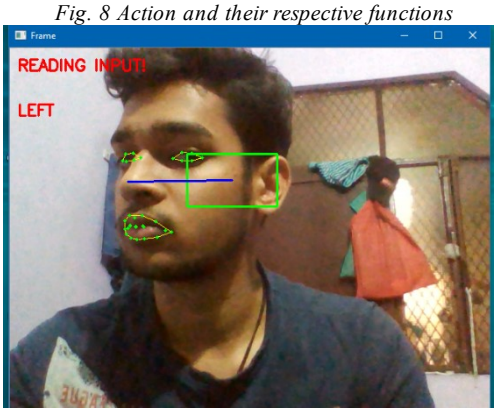


Fig. 9 Left Movement

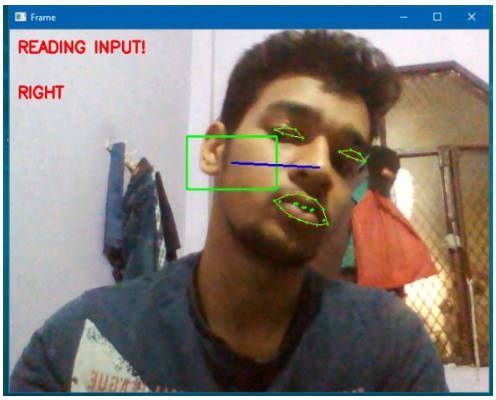


Fig. 10 Right Movement

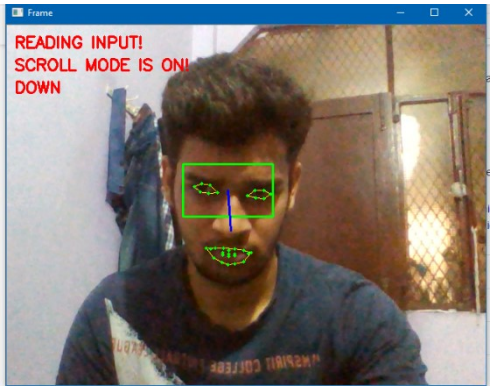


Fig. 11 Scroll Mode on with downward scrolling

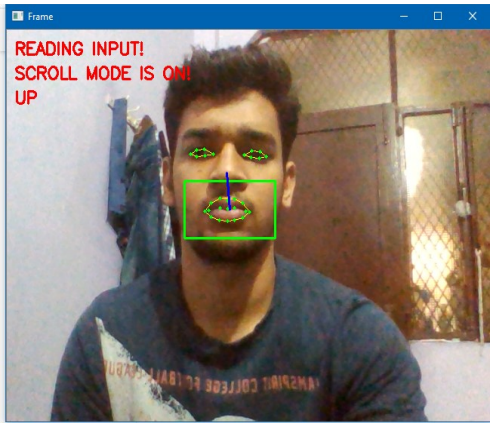


Fig. 12 Scroll Mode on with upward scrolling

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