Mouse Cursor Movement and Control using Eye Gaze- A Human Computer Interaction

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***Abstract*—An emerging technology is human computer interaction (HCI). One of the most important HCI strategies is the eye gazing method, which enables the user to operate the display without using their hands. Direct eye movement detection, template, appearance, feature, hybrid, regression, clustering 3D methods are all ways to categorize eye gaze detection techniques. Deep learning, a technology that mimics human behavior and features like speech recognition, image recognition, and language translation can make this possible. A web camera was employed in this study to capture a frame of an eye frame for mouse cursor movement. In connection with the point previously mentioned, we must first concentrate on the function of our eye. We are employing a web camera for pupil identification, which can manage the computer's cursor. For this paper, an Aspect Ratio Eye (EAR) is determined that corresponds to the blinks of eye's (right or left) applying the library of Mediapipe which is open source and acts as a computer vision library. You can provide smart people with crippled limbs who are having trouble using computers a chance to express their opinions. Here, the method's objective is improving the experience of using computer for physically disabled people by assisting them in overcoming challenges using a mouse.**

Keywords-Eye Gaze; Human Computer Interaction; Feature-based Classification; Conventional Mouse

I. INTRODUCTION

Moving a computer mouse using finger has become a typical method of moving the computer cursor currently moving around the computer screen technology. To align it with the motions of the system notices any movement of the cursor follow human finger or computer mouse. This is using present technology will not be possible referred to by some as "amputees" since they do not the ability to use their hands. As a result, the amputee and other people with physical disabilities can if their eyeball movement can be controlled, they will be to the cursor, mapped. Depending on how the movement and direction of the eyes are seen tracking the direction an eye is looking, the physically mapped cursor will be used disable individuals will be able to move the cursor. From the past, hand disabled person are deprived to use computer or laptop for this reason and they took themselves too far from the new technologies. Though having enough knowledge on modern technology, they cannot utilize their knowledge because of their disability. We have thought about intelligent disabled persons and proposed the system that can play a great role for these persons so they can utilize their knowledge to do something.

This technology has been the subject of extensive development in recent years with the goal of making it accessible to the general population. First, three different technologies were used to construct eye trackers, which monitor eye movement. These three methods include optical tracking, which uses light to measure the motion of eye, and potential electric measurement, which is being used to calculate eye's moment of dipole to determine motion of eye. Eye attached tracking involves attaching a device to the eye, such as a contact lens.

Then, using the information gathered by the tracker, several methodologies were created in order to identifying the x, y coordinates of the screen region the user is viewing. This information was then used to carry out a variety of generic activities in human computer conversation, including object selection, object movement, text scrolling, and other [1]. The proposed technology is a hand free communication system between human and computer on the concept of Human-machine-interaction (HMI). External webcam is being used to take input from human and control the cursor based on this input. Taking input is a real time process [2]. Also the technology will exchange traditional screen pointing method to a smarter and new process [3].

In this paper, we proposed a multimodal camera-face human machine interface architecture where acknowledging eye movement tracking has been completed. Constant eye input has traditionally been employed for individuals who are unable to move their eyes but can able to use them as an input.

II. BACKGROUND STUDY

Interest in creating a method for studying eye movements has grown recently. Numerous algorithms, models, and strategies have been examined in this research survey. The findings of the survey have helped identify certain crucial factors and aspects that have a significant impact on the accuracy and efficiency of eye gazing processes. In order to conduct additional research and analysis, a variety of eye gaze-based HCI models and algorithms have been examined. Below is a discussion of the advantages and disadvantages of eye gaze-based models.

A Visual Analytic in Deep Learning Approach to Eye Movement for Human-Machine Interaction Based on Inertia Measurement, 2020 [2]. This method uses the user's eye

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gaze to control the computer cursor. A user can type, run computer software, use a computer mouse, access the internet, and create voice syntheses by staring at the control keys that are visible on the screen. The sole requirements for using the eye gaze are the ability to maintain a relatively stable head position and control of at least one eye with decent vision. The technology employs an external speech device and outputs fair results.

Eye gaze estimation is a process that use human computer intersection (HCI). Gaze pointing method bring a new process which control cursor in screen with eyeball rotation instead of traditional mouse. Eye gaze pointing and eye gaze direction both were estimated by Yong Huang and his team 2021 [4]. They constructed local sharing network for feature extraction and propose Multiview Multitasking Learning (MML) for gaze direction. Information were taken from eyes as input in real time. Neural light method is a kind of method that use infrared light source to implement a gaze estimation. Some limitation was faced like changing in the visible light spectrum and low contrast images, but it is less sensitive to infrared light.

A strategy for human-computer interaction based on eye movement was put forth by Ramsha and Usmani in an article published in 2016 [5]. Our paper is dedicated to outlining also implementing a human-machine interfaced framework which traces the movements of the user's eye while using EAR equation to move the mouse cursor while using eye pupil implementation, and Eye squints, an eye movement, are used while closing and opening a certain sign. The sixth sense technology, developed by a team at MIT [6], promises to improve HCI by using palm and eye motions. The complete system may be mounted on the person's helmet in order to be operated anywhere around the globe and displayed onto flat surfaces. It does not offer a good solution that really can communicate with other suitable devices or ensure access and support for the impaired. Mr. Yushou Tang and Jianhuan Su propose a model that predict human emotion based on eye movement. They thought that eye movement can express human emotion and so they use back-propagation (BP) algorithm to gaze eye movement [7].

Sidrah liaqat and his co-author's proposed a model on predicting ASD diagnosis in children based on eye gaze process. They tried to predict autism spectrum disorder on young children at a very early age. They proposed two machine learning method for implementation. The first method is synthetic saccade pattern which is used to represent the baseline scan-path and the other method is image based which adopts a more holistic image based approach by feeding the input image and a sequence of fixation maps into a state-of-the-art convolutional neural network [8]. Using gaze estimation, a model was proposed to predict driver's eye fixation to ensure safe driving in autonomous vehicles. Convolution neural network predict the potential saliency regions in the driving environment and then use the probability of the driver gaze direction, given head pose as a top-down factor [9]. Tracking the driver's eye movement, gaze direction and gaze movement with real time the driver's next action is being predicted and can make a judgment on safety and risk level.

Mohd Khalel published a work [10] which concentrates on the usage of MATLAB to operate the pupil detection mechanism. Using a web camera, the head will be first identified, followed by the eye, which is then extracted using the MATLAB library, leading towards the monitoring of gaze. The iris transition would then be determined by calculating, and the transition would then be plotted using a graphical interface. The eye is then identified, and this is plotted with cursor, and thus the mouse pointer moves in accordance. In another promising work proposed by Abdullah S. Almansouri [16] mentioned MATLAB code analysis approach to monitor eye movement. This study work on four eye direction: left/right, and up/down.

Eye gaze estimation taking a great contribution on eye blinking prediction. Nowadays eye blinking prediction method is used in various platforms like drowsiness detection, face recognition application, unlocking phones, etc. In raspberry pi3 gazing eye blink is estimated in 2021. Dlib library was utilized to detect facial features. Eye aspect ratio (EAR) was built to detect the blink. It provides an accurate calculation using the ratio of distance among the eye landmarks [11], [13], and [14].

Pupil center movement was being tracked dynamically. Gaze estimation expresses feelings, desires, emotions, and in tension. A person-dependent calibration-free system could deal with the illumination [12]. Examining and establishing the variables that capture the changes caused by blinking in this article study. Face detection is performed using the Mediapipe technique, while eye extraction is performed via template matching. The eye part is removed using specific geometric dependencies. Eye tracking is carried out in its first stages via template matching. For cursor movement, face classifiers were utilized (such as up, down, left, and right). The major steps of this system are: 1) it recognizes faces in videos; 2) it extracts eyes; and 3) it extracts features; and finally, it recognizes cursor movement and mouse events. On the other hand, OpenCv and neural networks also introduced and used for developing a system for eye movement detection [15].

In recent years, several machine learning(ML) techniques, such as random forest, decision tree, k-nearest neighbor, and support vector machine(SVM) are familiar for achieving success in this field. S Akshay et al. [17] claimed ML algorithms for tracking eye movement using raw data of eye movement. In addition to eye tracking classification also focus by research scholar. In 2021, Thibhika Ravichandran et al. [18] proposed ML based approach to classify eye movement. Here, long-short term memory (LSTM) and convolutional neural network (CNN) applied and got 88.3% and 90% accuracy, respectively. Yuehan Yin et al. [19] also proposed CNN for eye movement classification. After data pre-processing and feature engineering they applied keras framework on tensorflow for CNN model.

After observing several research works proposed by research community, in this study proposed a system for disable people to monitor personal computer using eye movement.

III. Proposed Methodology

In this study, Mediapipe is used to track eye movement to control computer mouse pointer movement. Eyeball movement is identified by the camera and analyzed by MediaPipe. Real-time computer vision is the main emphasis of a suite of programming interfaces called MediaPipe. PyAutoGUI library is used here. The automation library PyAutogui for Python supports keyboard and mouse control.

Alternately, automate keyboard and mouse clicks in order to establish interaction with another program using a Python script. This allows for cursor control. The user is required to stand in front of the personal computer screen, and a dedicated video camera mounted above a computer or laptop's screen to record the user's gaze. The laptop continuously analyzes the attention's video image to determine where the user is addressing the monitor. Figure 1 illustrates the overall working procedure of this study.

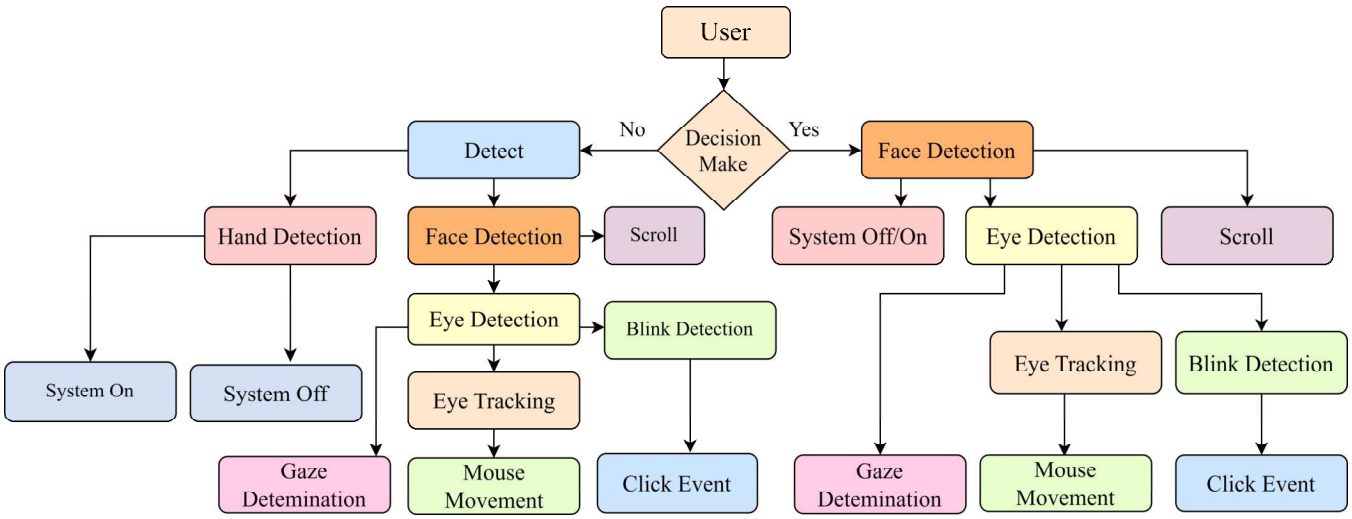


Figure 1. Overview of Proposed System.

MediaPipe Facemesh will detect the face and divide it into se of landmarks to identify facial movement. From mediapipe detected face we will measure head movement to determine scroll event. When user will open and close their mouth system will turn itself off/on. By extracting eye pacement from MediaPipe we will determine where to place the cursor. From the detected landmark for both eye we will detect distance between upper eyelid and lower eyelid. If we detect that the distance between the eyelids is very low, we will execute following click event. For a user who is not disabled our system will follow same set of execution order as we saw for disabled user but this user will also be able to use his hands to turn the system off and on.

A. Maintenance of the Mouse Pointer

The center of the iris is where the pupil, which is the focal point of the eye, is located. Light enters the eye through the pupil; hence the main focus of the suggested technique is locating the pupil. The pupil of the subject serves as the source of eye movement information. When the user looks at the mouse cursor in the middle, the cursor starts to travel in the direction of the user's gaze movement and stops when the user's eye lands on its starting point. This serves as the input point for gaze tracking for cursor movement.

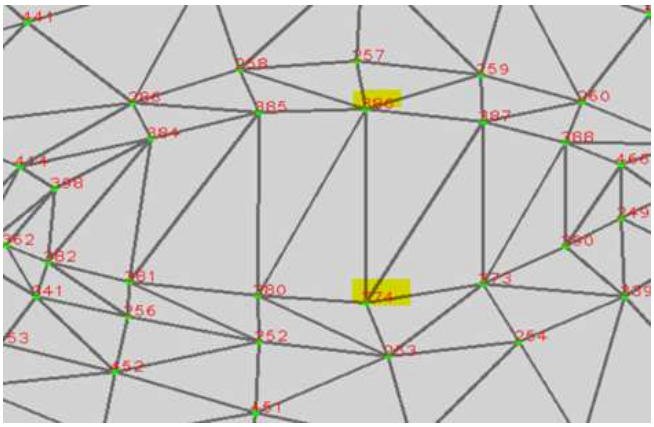
- Circular artifacts can be used to move the eye's pupil horizontally. The mouse pointer moves in lockstep with the pupil, so if the pupil moves to the left, it will also move to the left if it moves to the right. Sample input shown in Figure 2.

Figure 2. Left Side Movement and Right Side Movement.

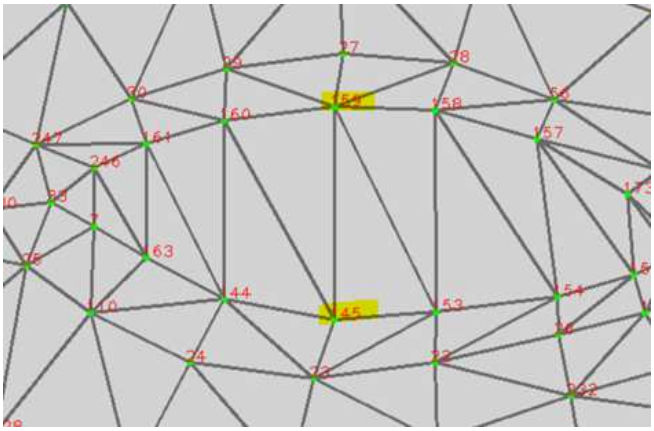
- A pupil scale can be used to move the eye's pupils vertically. When looking downward, the eyes are slightly half-closed. These phenomena can be exploited to direct the mouse pointer's movement from top to bottom, presents in Figure 3.

Figure 3. Pupil Upwards and Pupil Downwards.

- The functionalities of the right click and left click will be accessed through right eye winking and left eye winking. For the left eye wink detection landmarks 145159 was used in Figure 4 (b), and for the right eye wink detection landmarks 386374 was used in Figure 4 (a).



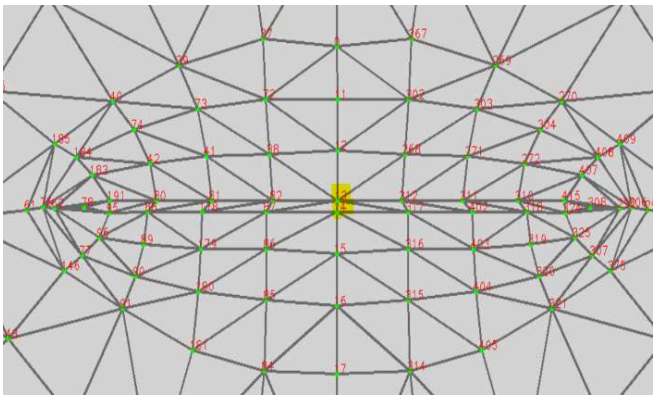
a). Right Eye Landmarks.



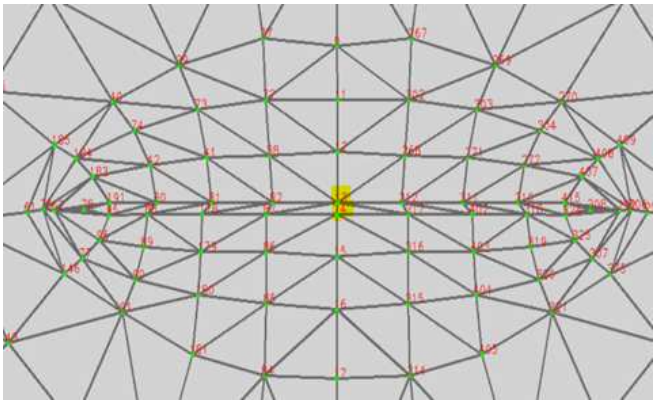
b). Left Eye Landmarks

Figure 4. (a) Right Eye Landmarks, and (b) Left Eye Landmarks.

- Most of the time it will be a must to scroll a page, without scrolling we can't actually provide a good usage. For scrolling, users need to move their head. Move up and down will scroll up and downwards. In the same manner, moving the head right and left will scroll right and leftwards.
- User will be able to turn the system on when turned off by opening their mouth. When the system is turned on users will be able to turn it off by simply opening their mouth. Here we calculated the distance of landmarks 1314 to determine the distance between lips. That whole processes are shown in Figure 5 (a) and (b).
- Users will be able to turn the system on by opening their hand. When the system is turned on users will be able to turn it off by closing their hand.



a). Mouth Landmarks



b). System Off/On

Figure 5. (a) Mouth Landmarks and (b) System Off/On.

IV. Result Analysis and Discussion

The accuracy of the system should have been 100 percent, but external factors like light intensity, an average camera, and others caused it to be a little low. After much trial and error, the accuracy is now between 80 and 95 percent, with the maximum average accuracy occurring in bright sunlight and a decrease to 85 percent at night. If the illumination is good, the device will provide a decent percentage of accurate reading.

TABLE I. Eye Aspect Ratio Values.

Eye Features	**Ratio**
Open fully	0.36-0.44
Open partially	0.31-0.37
Closed fully	<0.15
Right wink	0.12-0.18
Left wink	0.12-0.18

Table I prepared for presenting the eye movement taking ration. To understand the outcome of this, work several results are visualized in Figure 6. After considering various input forms, such as eye detection situation, system on-off

process using mouth, left click and right click using eyes. We prepared the visual results to observe the proposed system's performances.

Figure. 6. Device Monitoring using Eye Gaze.

V. Conclusion and Future Direction

This research proposed a novel HMI system for manipulating a pointer on the computer screen while tracking the user's eyes. It uses computer vision and pattern recognition techniques. The following solution, which uses PyAutoGUI, will give physically disabled users an alternative method of interacting with real-world programs in a better and more effective way. This particular technology allows physically challenged individuals greater adaptability by allowing them to simulate mouse pointer action just using facial recognition. Additionally, even non-disabled users will be able to use this system and thus it can be concluded that further utilization of this system while updating the framework and graphical user interface will revolutionize the IT world for the better and take gesture base computing to a new milestone.

Our system is now totally dependent on a laptop but it will be great if you could work with that without implementing it in the computer rather than running it using raspberry pi3. Making cursor movement faster and slower will also give a lot of application. For gaming, we may introduce multiple control systems which will revolutionize the gaming experience. Implementing the whole thing alongside virtual reality (VR) will provide an experience never experienced before. In near future we will try to implement this system on personal computers, mobile phones and other digital devices. We hope that most of the device which controls by a mouse and screen touch system will replace into eye movement controlling technology in upcoming new generation.

References

[1] Robert J. K. Jacob, "The use of eye movements in human-computer interaction techniques: what you look at is what you get". ACM Trans. Inf. Syst. 9, 2, pp. 152–169, 1991. doi: 10.1145/123078.128728

[2] Fahim, Shahriar Rahman, et al., "A visual analytic in deep learning approach to eye movement for human-machine interaction based on inertia measurement." *IEEE Access* 8: 45924-45937, 2020.

[3] V. Khare, S. G. Krishna and S. K. Sanisetty, "Cursor Control Using Eye Ball Movement". 5th International Conference on Science Technology Engineering and Mathematics (ICONSTEM), 2019, pp. 232-235, doi: 10.1109/ICONSTEM.2019.8918780.

[4] Huang, Yong, Ben Chen, and Daiming Qu, "LNSMM: Eye gaze estimation with local network share multiview multitask". *arXiv preprint arXiv:2101.07116* (2021).

[5] R. Fatima, A. Usmani and Z. Zaheer, "Eye movement based human computer interaction". 3rd International Conference on Recent Advances in Information Technology (RAIT), pp. 489-494, 2016, doi: 10.1109/RAIT.2016.7507950.

[6] Mistry, Pranav and Maes, Pattie, "SixthSense: a wearable gestural interface". ACM SIGGRAPH ASIA 2009 Sketches. 85. doi: 10.1145/1667146.1667160.

[7] Tang, Yushou, and Jianhuan Su, "Eye movement prediction based on adaptive BP neural network". Scientific Programming (2021).

[8] Liaqat, Sidrah, et al., "Predicting ASD diagnosis in children with synthetic and image-based eye gaze data". Signal Processing: Image Communication 94 (2021): 116198.

[9] Shirpour, Mohsen, Steven S. Beauchemin, and Michael A. Bauer, "Driver's Eye Fixation Prediction by Deep Neural Network". VISIGRAPP (4: VISAPP), 2021.

[10] Mohd Khalel, M. N., Mujeeb Rahman, K. K., Zubair, M., Ansari, H. & Mohamed, F., "Eye-controlled mouse cursor for physically disabled individual". Advances in Science and Engineering Technology International Conferences, ASET 2018: 1–4. doi: 10.1109/ICASET.2018.8376907.

[11] Ibrahim, Bishar R., et al., "Embedded system for eye blink detection using machine learning technique". 1st Babylon International Conference on Information Technology and Science (BICITS). IEEE, 2021.

[12] Cazzato, Dario, et al., "Real-time gaze estimation via pupil center tracking". Paladyn, Journal of Behavioral Robotics 9.1 (2018): 6-18.

[13] Chandra, B., M. Rohit, and R. Sriram Vignesh, "Eyeball Movement Cursor Control Using OpenCV". *ECS Transactions* 107.1 (2022): 10005.

[14] A. Sivasangari., D. Deepa., T. Anandhi, A. Ponraj and M. S. Roobini, "Eyeball based Cursor Movement Control". International Conference on Communication and Signal Processing (ICCSP), 2020, pp. 1116-1119, doi: 10.1109/ICCSP48568.2020.9182296.

[15] Sharanyaa, S. and K, Yazhini, R. P, Madhumitha and Rani.B, Yamuna, "Eyeball Cursor Movement Detection Using Deep Learning" Proceedings of the International Conference on Innovative Computing & Communication (ICICC) 2021, doi: 10.2139/ssrn.3884881

[16] A. S. Almansouri, "Tracking Eye Movement Using a Composite Magnet". IEEE Transactions on Magnetics, vol. 58, no. 4, pp. 1-5, 2022, Art no. 5200305, doi: 10.1109/TMAG.2022.3152085.

[17] S. Akshay, Y. J. Megha and C. B. Shetty, "Machine Learning Algorithm to Identify Eye Movement Metrics using Raw Eye Tracking Data". 3rd International Conference on Smart Systems and Inventive Technology (ICSSIT), 2020, pp. 949-955, doi: 10.1109/ICSSIT48917.2020.9214290.

[18] T. Ravichandran, N. Kamel, A. A. Al-Ezzi, K. Alsaih and N. Yahya, "Electrooculography-based Eye Movement Classification using Deep Learning Models". IEEE-EMBS Conference on Biomedical Engineering and Sciences (IECBES), 2021, pp. 57-61, doi: 10.1109/IECBES48179.2021.9398730.

[19] Yin, Yuehan, Chunghao Juan, Joyram Chakraborty, and Michael P. McGuire, "Classification of eye tracking data using a convolutional neural network". 17th IEEE International Conference on Machine Learning and Applications (ICMLA), pp. 530-535. IEEE, 2018.