International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9, Issue-7, May 2020

Eyeball Movement based Cursor Control using Raspberry Pi and OpenCV

J. Sreedevi, M. Shreya Reddy, B. Satyanarayana

Abstract: ***In this study, a specific human computer interaction system using eyeball movement is presented. Conventionally, computer system uses mouse as one of the data input devices. But in this system, we use eyes instead of mouse which provides a unique way of operating the computer with the help of eyeball movements. The implementation work underlying this system for pupil identification uses raspberry pi board to control the cursor of the personal computer and moreover Eye Aspect Ratio technique is ascertained along with OpenCV to detect the pupil. This system tracks the eye movements of the user with an IP cam (Internet Protocol camera) and simulates the eye movements into mouse cursor movements on screen and also detects user's eye staring on icon and will translate it into click operation on screen. The main aim of this system is to help the user to control the cursor without the use of hands and is of great use especially for the people with disability.***

Keywords: ***Eyeball movement, Mouse, Raspberry pi, IP Cam (Internet Protocol camera).***

I. INTRODUCTION

Nowadays, personal computer systems take a vast part in our day to day survival since they are used in areas such as at workplace etc. These applications have one thing in common i.e. the use of personal computers is mostly dependant on the data input methods such as mouse. But this is not a problem in case of a healthy individual, this may be a problem for people with less freedom of movement of their limbs [1]. In such cases, it might be preferable to use input methods which supports the abilities of the region such as eye movements. To enable such input method as a substitute, a system is designed which follows a low-cost approach to control cursor on a computer system without the use of mouse [6].

In the proposed system, the cursor movement of the computer system is controlled by the eyeball movement using OpenCV. This system comprises of Raspberry pi [5]. It is interfaced with IP camera which detects the Eyeball movements and based on these eyeball movements the cursor can be controlled accordingly which are processed using the Open CV (Open Computer Vision).

Revised Manuscript Received on May 30, 2020.
* Correspondence Author

J. Sreedevi*, Department of Computer Science and Engineering, Mahatma Gandhi Institute of Technology, JNTUH, Hyderabad, INDIA. Email: jsreedevi_cse@mgit.ac.in.

M. Shreya Reddy, Department of Computer Science and Engineering, Mahatma Gandhi Institute of Technology, JNTUH, Hyderabad, INDIA. Email: reddyshreya1699@gmail.com.

Dr. B. Satyanarayana, Department of Mechanical Engineering, VNR VJIET, Hyderabad, INDIA. Email: sanbollu@gmail.com

II. PROPOSED METHODOLODY

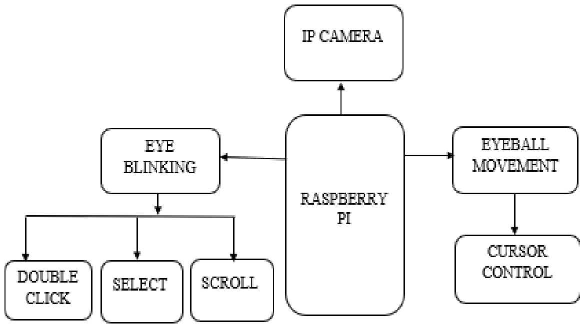

Fig 1. Block diagram of eyeball movement-based cursor control

In the figure 1, Raspberry pi is used with ARMv8 (BCM2837) processor pace with 1 GB of RAM and in-built Wi-Fi. An Internet Protocol camera (IP Camera) is associated with the Raspberry pi keeping in mind the end goal to supply PC vision to the machine. The IP camera will grab the eye movement and subsequently controls the cursor. Likewise, it will also perform the activities like double click, scrolling and selection.

This system involves mainly the following steps. They are,

1.IP cam captures the eyeball movements which are processed using OpenCV

2. Eye Aspect ratio (EAR) technique for pupil detection

3. Frames getting started and EAR values being detected based on the eyeball movements.

4. Controlling the cursor to perform various operations such as scroll, select and double click.

A. Hardware Requirements

1. Raspberry pi
2. SD card
3. Mobile phone installed with IP cam
4. Monitor

B. Software Requirements

1. Raspbian OS
2. OpenCV
3. Python Programming Language

III. IMPLEMENTATION

This study is mainly concentrated around predicting the eyeball movements. Before detecting the eyeball movements, we need to identify the facial landmarks [4]. We can attain a lot of things using these landmarks. We can detect eyeball movements, eye blinks in a video and also predict emotions [8].

Understanding the dlibs facial landmark finder: Dlib's model, not only does a faster face-detection but also allows us to predict the 68 2D facial landmarks accurately.
The records of the 68 directions can be imagined in the picture shown in the figure 2.

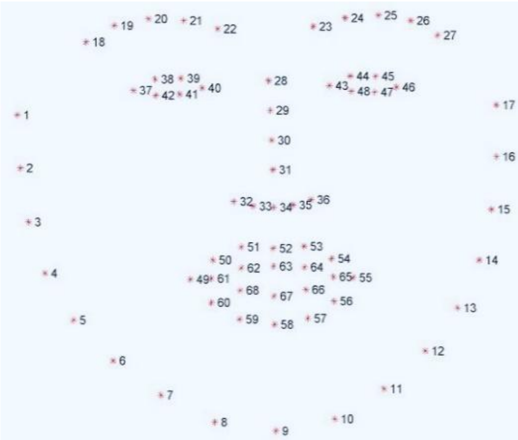

Fig 2. Picturing the 68 facial landmark positions

For eye ball movements detection, only eyes are considered. The eye is denoted with 6 (x, y) coordinates starting from utmost left corner and moving towards right in a clockwise direction covering the remaining area of the eye as shown the figure 3.

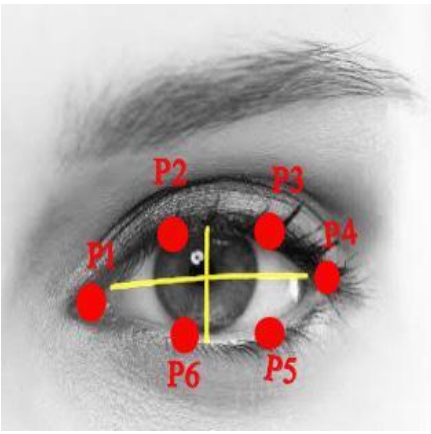

Fig 3. The 6 facial points linked with the eye.

Based on the research work carried out by Soukupová and Čech in the Real-Time Eye Blink Detection using Facial Landmarks system [3], an equation can be derived which satisfies the relation between all 6 facial co-ordinates called eye aspect ratio and it can be calculated as follows:

$$\text{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

In the above equation, points p1,...p6 are considered as two-dimensional facial landmark positions.
Distance between the vertical points of the eye are substituted in numerator and the distance between horizontal points of the eye are substituted in denominator of the equation. When eyes are wide open, eye aspect ratio will nearly be constant and at the time when the person blinks his eyes, the value falls down to zero [3].

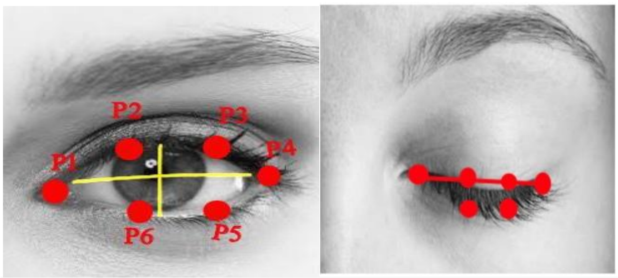

Fig 4. Landmarks of the eye when the eye is fully open (left) and landmarks of the eye when the eye is closed (right).

Eye aspect ratio will be larger and remains constant over the time when user's eyes are fully open as seen in the figure 4 (Left). Eye aspect ratio decreases drastically and approaches to zero when the person blinks as shown in the figure 4 (Right). And also, eye aspect ratio remains same over the time and it slowly drops near to zero. It then increases over representing that the person has blinked once [7].

Flowchart:

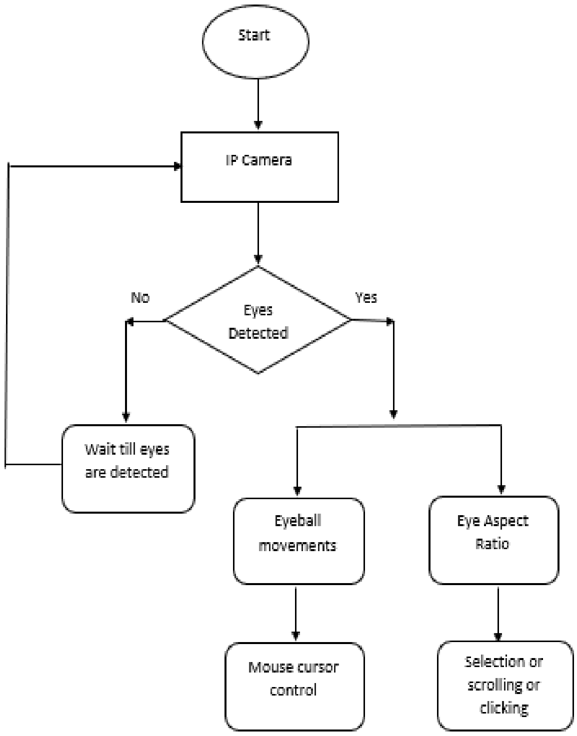

Fig 5. Flowchart of overall process in eyeball movement-based cursor control

The above flowchart speaks about the overall process carried out in eyeball movement-based cursor control using Raspberry pi and OpenCV. Raspberry Pi is the main element in processing module which monitors the eye movements by interfacing with Internet Protocol camera. The camera waits until the eyes are recognised and then it captures the image. Eyes are recognized utilizing the picture handling mechanism of OpenCV technology. Based on the eyeball movement, the mouse cursor can be controlled and blinking of the eyes are utilized to figure out the Eye Aspect Ratio (EAR) to perform various operations such as clicking, scrolling or selecting.

IV. RESULTS AND DISCUSSION

Before running the python software, change the current working directory and then run the python software by entering the commands in the terminal as shown in the figure 6.

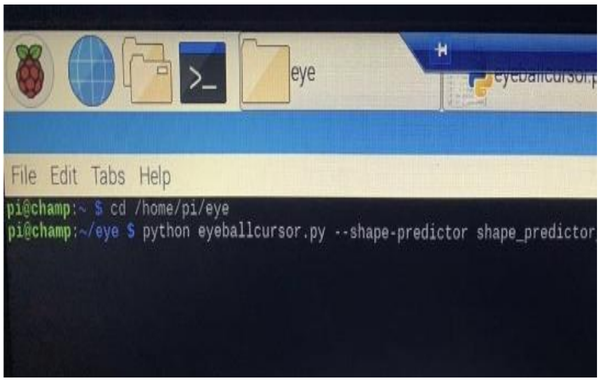

Fig 6. Running Python software

We need to install IP Webcam app on our mobile phone. After installing the app, click on 'Start Server' in the app settings so that video stream starts after running the python software as shown in the figure 7.

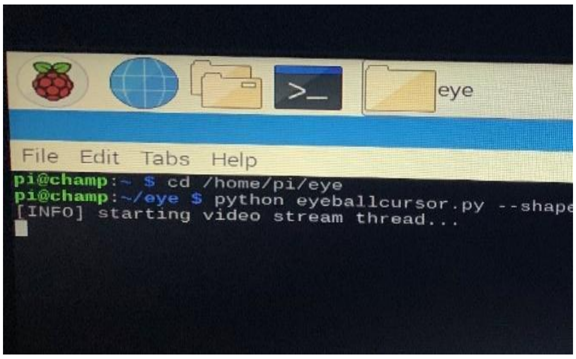

Fig 7. Starting video stream

After starting the video stream thread, the frame gets started with the eye aspect ratio values being detected as shown in the figure 8.

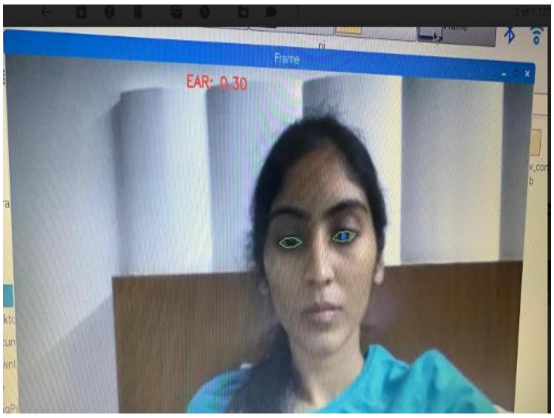

Fig 8. Frame getting started and Eye Aspect Ratio values being detected.

In the figure 9, we can see that eyes are in a normal position. So, value of eye aspect ratio is 0.35 that is considered constant.

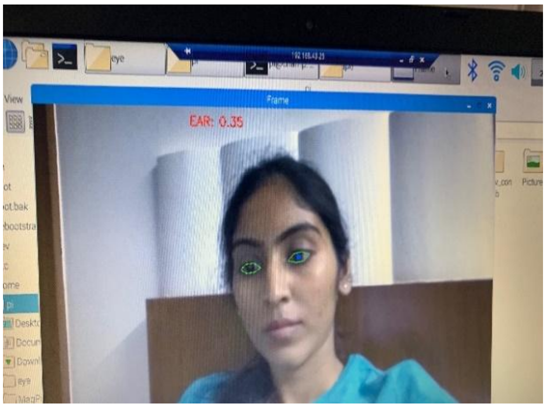

Fig 9. Eye Aspect Ratio value being constant when eyes are in a normal position.

In the figure 10, we can see that eyes are fully opened. So, value of eye aspect ratio has increased to 0.38 and accordingly the cursor is controlled.

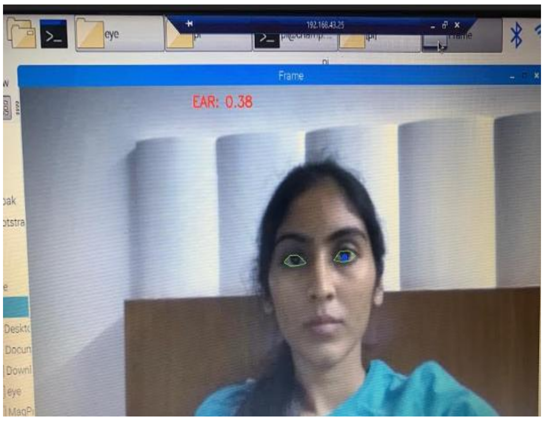

Fig 10. Increase in eye aspect ratio value when eyes are wide open.

In the figure 11, we can see that eyes are half closed. So, the eye aspect ratio has decreased to 0.28 and we can also see the cursor pointing on the frame tab.

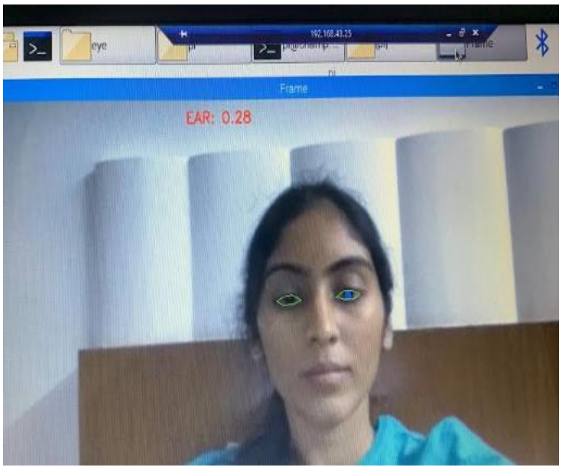

Fig 11. Decrease in value of eye aspect ratio when eyes are half closed.

Retrieval Number: G5187059720/2020©BEIESP
DOI: 10.35940/ijitee.G5187.059720
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Table- I: Eye Aspect Ratio (EAR) values when eyes are fully closed, partially opened and fully opened

EAR values when eyes are fully closed	EAR values when eyes are partially opened	EAR values when eyes are fully opened
<0.28	0.28- 0.37	0.38- 0.42

IV. CONCLUSION

An eyeball movement-based cursor control using raspberry pi and opencv system is developed. The above experimental results show that we can control the functions of cursor efficiently without the use of the mouse. The operations performed using this system are easy in terms of controlling the cursor [2]. This system is a possible solution to all the problems that are faced due to the existing manual of controlling the cursor with the help of the mouse which is not possible in case of people with disability. This system offers users with new means to control the computer system. The work can be extended to improve efficiency of the system in terms of covering all the mouse functions using eyeball movements. Presently, this system can be useful for the overall operational behaviour by interacting with the computer system without the use of mouse. Through Eyeball movement-based cursor control system, it can be concluded that there can be considerable development in the field of human computer interface with the use of IoT.

FUTURE SCOPE

1. In the future, we can also add new functions which can be operable in useful circumstances to control the cursor by the user and implement this system on platforms like mobile phones, tablet etc.
2. In the future, we can also develop a series of operational units so that we can attain a fully operating experience for the handlers from turning on to turning off the computer system.

REFERENCES

1. Neil Castellino and Michelle Alva, “An image-based eye controlled assistive system for paralytic patients”, IEEE Conference Publications, 2017.
2. Shu-Fan Lin, Xuebai Zhang, Shyan-Ming Yuan, "Eye Tracking Based Control System for Natural Human-Computer Interaction", Computational Intelligence and Neuroscience, 2017.
3. Čech and Soukupová, “Real-Time Eye Blink Detection using Facial Landmarks”, Center for Machine Perception, February 2016.
4. Suree Pumrin and Chairat kraichan, “Face and eye tracking for controlling computer functions”, IEEE Conference Publications, 2014.
5. A. Geetha and M. Mangaiyarkarasi, “Cursor Control System Using Facial Expressions for Human-Computer Interaction”, Vol 8 Issue 1 APRIL 2014, ISSN: 0976-1353 International Journal of Emerging Technology in Computer Science & Electronics, pp 30-34.
6. Florina Ungureanu, Robert Gabriel Lupu and Valentin Siriteanu, “Eye tracking mouse for human-computer interaction”, IEEE Conference Publications, 2013.
7. Bacivarov, Ionita M., Corcoran,P. , “Statistical models of appearance for eye tracking and eye-blink detection and measurement”, Vol.54 , No.3, IEEE Transactions on consumer electronics, August 2010.
8. Grauman, K.; Betke, M.; Gips, J.; Bradski, G.R., “Communication via eye blinks- Detection and duration analysis in real-time”, IEEE Conference Publications, 2009.

AUTHORS PROFILE

J Sreedevi is working as a Assistant Professor in Department of Computer Science and Engineering at Mahatma Gandhi Institute of Technology (MGIT). She is a Life member of Computer Society of India. She has published various papers in International Journals and Conferences. Her areas of interest include Machine Learning, Artificial Intelligence and Image Processing.

M. Shreya Reddy is a under graduate student in Computer Science and Engineering department at Mahatma Gandhi Institute of Technology (MGIT). She has presented a paper in 6th International conference in RTEE and also published paper in Recent Trends in Electrical Engineering (RTEE). Her areas of interest include Image Processing, Internet of Things (IoT).

Dr B Satyanarayana is working as a Professor in Department of Mechanical Engineering at VNR Vignana Jyothi Institute of Engineering and Technology (VNR VJIET), Hyderabad. He is a member of few Professional Societies. He has published more than fifty papers in International Journals and Conferences and authored two books.