MOUSE USING EYE TRACKING

A Mini Project Report

Submitted to the APJ Abdul Kalam Technological University

in partial fulfillment of requirements for the award of degree

Bachelor of Technology

in

Electronics and Communication Engineering

by

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CERTIFICATE

This is to certify that the report entitled **MOUSE USING EYE TRACKING** submitted by **ABEL VARGHIS MATHEWS** (TVE21EC001), **AKSHAY VV** (TVE21EC007), **ARJUN ANIL** (TVE21EC015) & **BRISTO C J** (TVE21EC022) to the APJ Abdul Kalam Technological University in partial fulfillment of the B.Tech. degree in Electronics and Communication Engineering is a bonafide record of the project work carried out by them under our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

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DECLARATION

We hereby declare that the mini project report **MOUSE USING EYE TRACKING**, submitted for partial fulfillment of the requirements for the award of degree of Bachelor of Technology of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by us under supervision of Prof. ASWINI S H

This submission represents our ideas in our own words and where ideas or words of others have been included, we have adequately and accurately cited and referenced the original sources.

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Abstract

This abstract explores the emerging field of mouse tracking technology utilizing eye movements as a control mechanism. With the increasing demand for intuitive and efficient human-computer interaction methods, eye tracking presents a promising avenue for hands-free navigation in various applications, including assistive technology, gaming, virtual reality, and computer accessibility. This paper surveys the state-of-the-art techniques and methodologies employed in eye-based mouse tracking systems, highlighting advancements in eye tracking hardware, signal processing algorithms, and user interface design. Additionally, it discusses the challenges and limitations inherent in eye tracking technology, such as accuracy, calibration, and user fatigue, and proposes potential solutions and future directions for research and development. By leveraging the natural and precise movements of the eyes, mouse tracking using eyes holds great potential to revolutionize human-computer interaction paradigms, offering enhanced accessibility and user experience across diverse computing environments.

Acknowledgement

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Chapter 1

Introduction

The importance of hand-free technology is growing every day in today's world since individuals with physical impairments and limited hand control will otherwise not be able to utilize the developments in technology relevant to today's advancements. A highly relevant hands-free method for navigating through computer interface is mouse emulation using eye tracking which can effectively substitute the need for a traditional mouse which require physical interaction and would provide difficult for individuals with physical impairments. This method not only helps to overcome the requirement of physical interaction for accessing ever-growing technology but also allows them to stay at par with the developments taking place in the software industry every day. Mouse emulation using eye tracking can be effectively used not only in increasing productivity and user count, but also in leisure activities such as gaming, other leisure activities and effectively interact with the interface by simply moving their head.

1.1 Problem statement

Despite significant advancements in eye-tracking technology, mouse tracking using eyes still faces several challenges that hinder its usage in common mans life. These challenges include issues related to accuracy, calibration, robustness in varying environmental conditions, user comfort, as well as integration with existing software and hardware infrastructure. Additionally, the complexity and cost of eye-tracking hardware remain significant barriers to mainstream adoption, particularly in applications where cost-effectiveness is crucial, such as assistive technology for individuals

with disabilities. Addressing these challenges is essential to realize the full potential of mouse tracking using eyes and to ensure its seamless integration into everyday computing experiences for users across diverse contexts and abilities.

1.2 Project objective

The objective of this project is to develop a robust and user-friendly system for mouse tracking using eyes, aiming to enhance human-computer interaction across various applications. This system will focus on improving the accuracy, calibration, and reliability of eye-tracking technology, while also addressing issues related to user comfort and fatigue. Additionally, the project aims to explore innovative approaches for integrating eye tracking with existing software and hardware infrastructure, making it accessible and compatible with a wide range of computing environments. Ultimately, the goal is to create a seamless and intuitive interface that empowers users to navigate digital interfaces using natural eye movements, thereby improving accessibility and user experience in fields such as assistive technology, gaming, virtual reality, and beyond.

Chapter 2

Literature Review

Computers play an integral part in our daily life in terms of education, employment, productivity and almost all general activities. Mouse is the basic tool used to control movement of the cursor and for proper selection of required fields. Some may find it difficult to use a traditional mouse due to factors such as physical impairment, fatigue or other issues of either body or mind. To remedy this, certain access methods can be adapted to better enhance connectivity between the disabled and computers.

Several considerations need to be kept in mind when choosing an access method. Firstly, it is paramount to understand the need of the customer with respect to the computer. Secondly, it is needed to understand the requirements to perform the above chosen need. Thirdly, we need to understand the abilities lacked by the customer to perform the required activities. For example, someone who has an active but decreased range of motion in their hands may find a trackball easier to use than a regular mouse. Factors such as compatibility between device and computer requirements as well as hardware and software factors should also be considered.

This article presents current software and hardware alternatives to the standard mouse. Due to ever changing technology, relevant sites have been included to provide updated information on the mentioned program and product. Furthermore, several programs are also available free of cost in trail versions or demonstrations.

A major concern in performance is that although an individual does not have hand function, he can use part of their body to control an alternative pointing device such as those with cerebral palsy, spinal cord injuries or other disabilities. [1]

2.1 Mouse emulation alternatives

Although some individuals may not have the required range of motion or strength to control a traditional mouse or a hand-controlled alternate one, they may be able to use their head, eyes, and foot movements instead. We make use of mouse emulation technologies along with on-screen keyboards to allow the user to perform the required functions of a mouse such as clicking and scrolling.

Head control: We make use of head movements to alternatively emulate mouse control [2]

Speech recognition: Speech recognition software is used for input text and control computer applications. This method requires caliberation for different users and users will need to have consistent speech abilities to remember the commands as well as be able to cope with noise interference in the environment and other factors that may cause interference for communication between the user and the computer.

Figure 2.1: Eye gaze system

Eye movements: In order to achieve this two components are required .An eye gaze system which includes a device for capturing as well as recording eye motion and related eye data to control a computer or device. This method allows the customer to use only their eye movements to control the cursor and is very helpful for those that not only have limited body movement but also those with disabilities such as Parkinsons as well. An example of an Eyegaze system is the Quick Glance.

Foot control: In this method, all functions of the mouse are performed using both feet.The No-hands Mouse works with two-foot pedals. One pedal controls clicking while the other controls pointing of the mouse.This is some what an accurate but hard to learn method of interface . [2]

2.2 Summary

Mouse alternatives allow individuals with disabilities to access mouse functions for specific tasks. No one method works for everyone, and more than one method may be necessary for one person. Alternatives to traditional mouse allows individuals with specific disabilities or needs to better make use of the technology they would normally be missing out on. However we must understand that no one method works for anyone and sometimes, more than one method may be necessary for some to effectively control mouse emulation.

Chapter 3

Project Design and Testing

The project design and testing require several important steps including Code development in a suitable IDE, testing, and simulating using suitable simulation software like 32-bit OS for Raspberry Pi 4B.

On to the hardware implementation part we require Raspberry PI and Raspberry PI camera for working on the prototype.

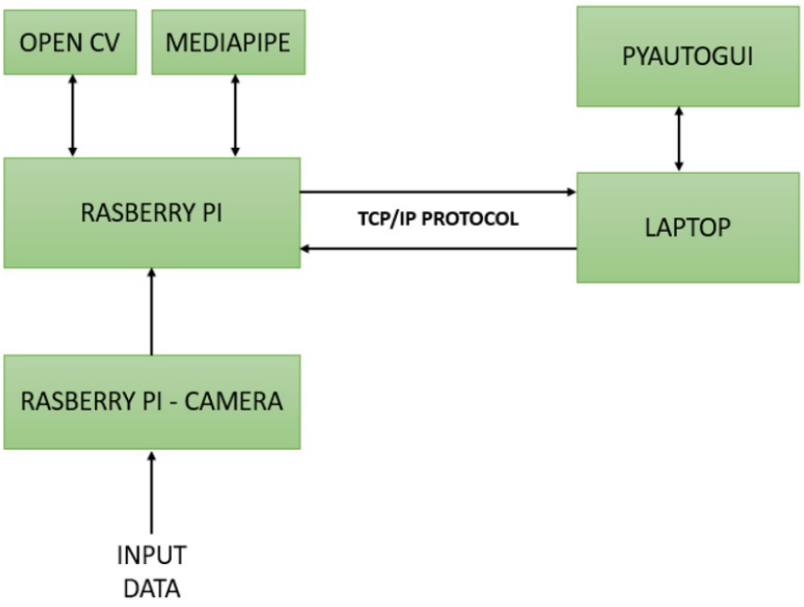

Figure 3.1: Block diagram

3.1 Prototype

3.1.1 Eye tracking code

Eye tracking code typically involves a combination of hardware interfacing, data processing, and algorithm implementation to capture and analyze eye movement data.

3.1.2 Mouse movement by eye tracking code

Mouse movement by eye tracking involves capturing and interpreting eye movement data to control the position of the computer mouse cursor. Here's a description of the process involved in implementing such functionality using code:

1. Eye Tracking Data Capture
2. Preprocessing and Filtering
3. Calibration
4. Cursor Control Algorithm
5. Mapping Gaze to Cursor Position
6. Cursor Update and Rendering
7. User Interaction and Feedback
8. User Interface Integration
9. Testing and Optimization
10. Documentation and Deployment

3.1.3 Demo code check

Step 1: Use the webcam of a laptop to track eye coordinates and move its own mouse cursor.

Step 2: Eye coordinates were tracked using the webcam of one laptop. These coordinates were then transmitted over a common WiFi network via the TCP/IP Protocol to another laptop, which utilized the data to move its cursor

Step 3: We eliminated the need for an external WiFi network. Instead, we configured one laptop as an access point, with the other laptop connecting directly to it.

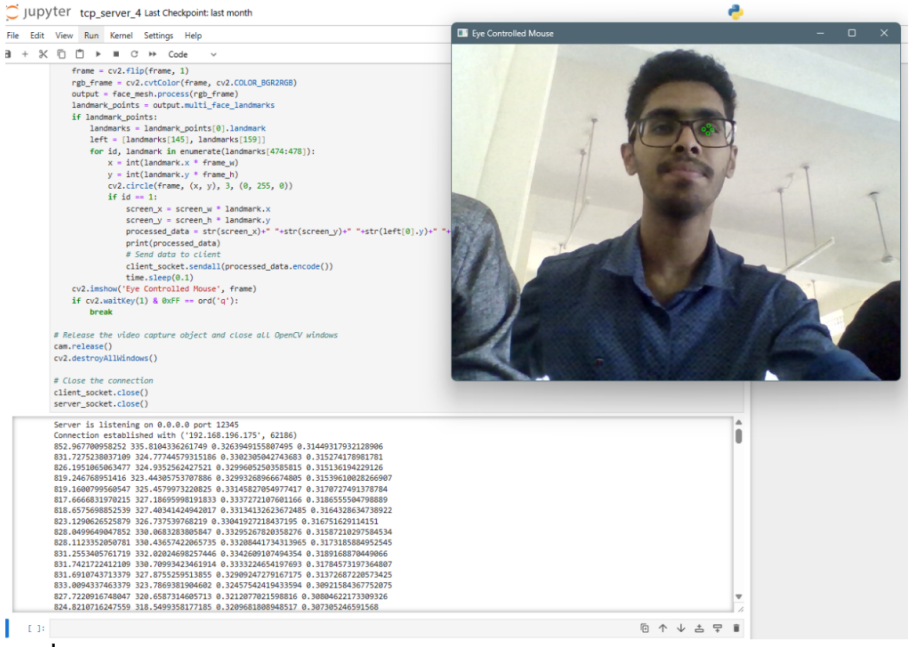

Figure 3.2: Eye coordinates

3.1.4 Libraries used

The project was done by using a virtual environment in order to avoid dependency clash while collaborating. [4]

Mediapipe library: MediaPipe is a powerful and versatile library for building real-time multimedia applications, offering a wide range of features, flexibility, and performance optimizations for developers working in fields such as computer vision, augmented reality, robotics, and more. [5]

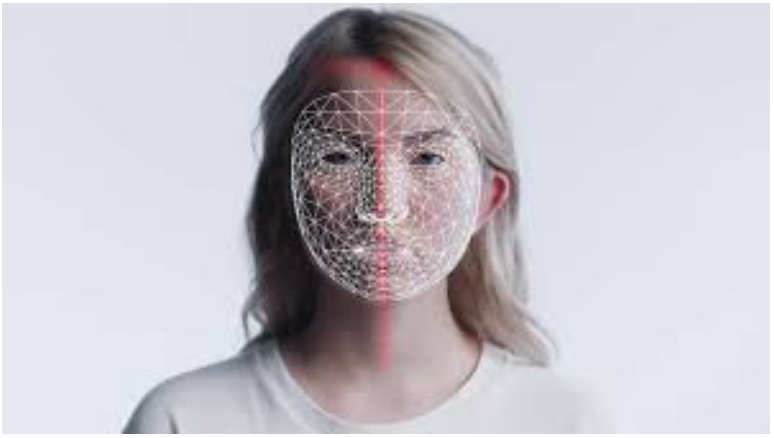

Figure 3.3: Face detection with mediapipe

PyAutoGUI library: PyAutoGUI is a Python library that provides a simple and cross-

platform way to automate tasks involving mouse movement, keyboard input, and screen interaction.It is a versatile and user-friendly library for automating repetitive tasks on your computer, whether you're creating macros, testing software, or building automated workflows for data processing and analysis. Its cross-platform compatibility, simplicity, and flexibility make it a valuable tool for both beginners and experienced Python developers. [6]

3.2 Product development

3.2.1 Raspberry Pi 3B

The Raspberry Pi 3 Model B is a powerful single-board computer developed by the Raspberry Pi Foundation. It features significant improvements over its predecessors, offering enhanced performance, connectivity, and versatility in a compact form factor.

It also includes built-in dual-band Wi-Fi, Gigabit Ethernet, Bluetooth 5.0, and a variety of ports, including USB 3.0, HDMI, and GPIO headers, making it suitable for both standalone use and integration into custom hardware projects. Here we're using it as a standalone product,which is user friendly and seamless to use.

Used as an access point for data transmission via TCP/IP to a PC. Utilizing the Mediapipe library and OpenCV, extending its capabilities beyond basic computing tasks. [3]

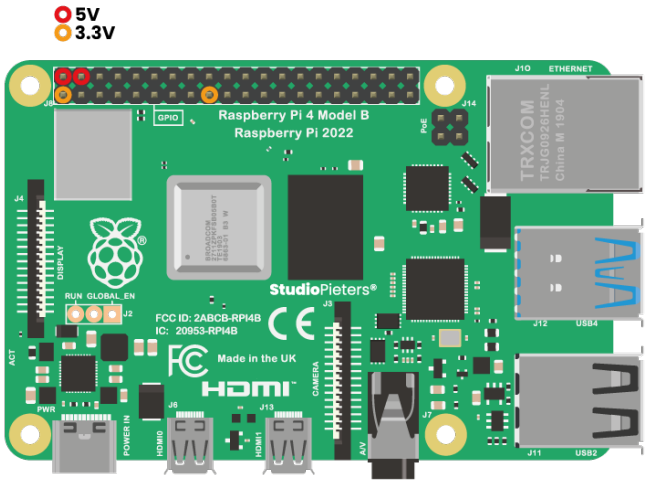

Figure 3.4: Rasbperry Pi 3 model B

3.2.2 64-bit Raspbian OS

The 64-bit Raspbian OS, also known as Raspberry Pi OS (formerly Raspbian), is an operating system optimized for the Raspberry Pi platform, specifically designed to uphold the capabilities of 64-bit ARM architecture. It offers improved performance, increased memory addressing capabilities, and support for larger memory configurations compared to its 32-bit counterpart.

The 64-bit Raspbian OS maintains compatibility with somewhat existing software and libraries, ensuring seamless migration for users and developers.Due to the dependency issues of Mediapipe library and OS issues of rpi camera we had to use USB camera as an alternative for rpi camera.

Overall, the 64-bit Raspbian OS offers improved performance and compatibility while retaining the ease of use and versatility that have made Raspberry Pi a preferred platform for various projects and applications.

64 bit OS for Raspberry Pi 4B was Configured and Installed. [7]

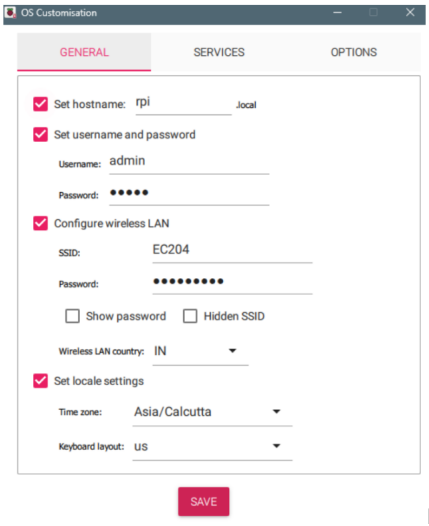

Figure 3.5: 64 bit raspbian OS

3.2.3 1/4 Cmos 640X480 USB Camera for Raspberry Pi

1/4 Cmos 640X480 USB Camera with Collapsible Cable for Raspberry Pi is a compact size and easy-to-carry one. With a retractable USB cable, it provides great convenience for use. What's more, it supports 300k pixels and has a USB 2.0 port for convenient use, is really a plug-and-play device. Though small, its max resolution reaches 640 x

480. Thus, this camera is quite suitable for RPi smart cars, robots, etc. This camera is compatible with all versions of Raspberry Pi

Figure 3.6: 1/4 Cmos 640X480 USB Camera

3.2.4 Auto startup

The product is meant for people with disabilities, so we aimed to make the device fully automatic. Our prime idea was to provide a power source for the device and instantly the camera of the product started tracking eye movements and thus replacing the mouse. In order to achieve this we used the startup file rc.local in rpi OS.

Entering sudo nano /etc/rc.local into the terminal we can edit this script, and then we insert the program location you want to run and the executable call before the exit 0 text. Thus upon startup, the rpi will run the transmitter side program.

On the receiver side, we created an application which,when called runs the python script for the receiver side.

Thus when the device is provided a power source(in our case a USB port of the laptop is sufficient)the rpi automatically waits for the receiver side application to run and once executed we can use our eyes as the mouse. Thus we made the device semi-automatic.

Figure 3.7: RPI CAM Application

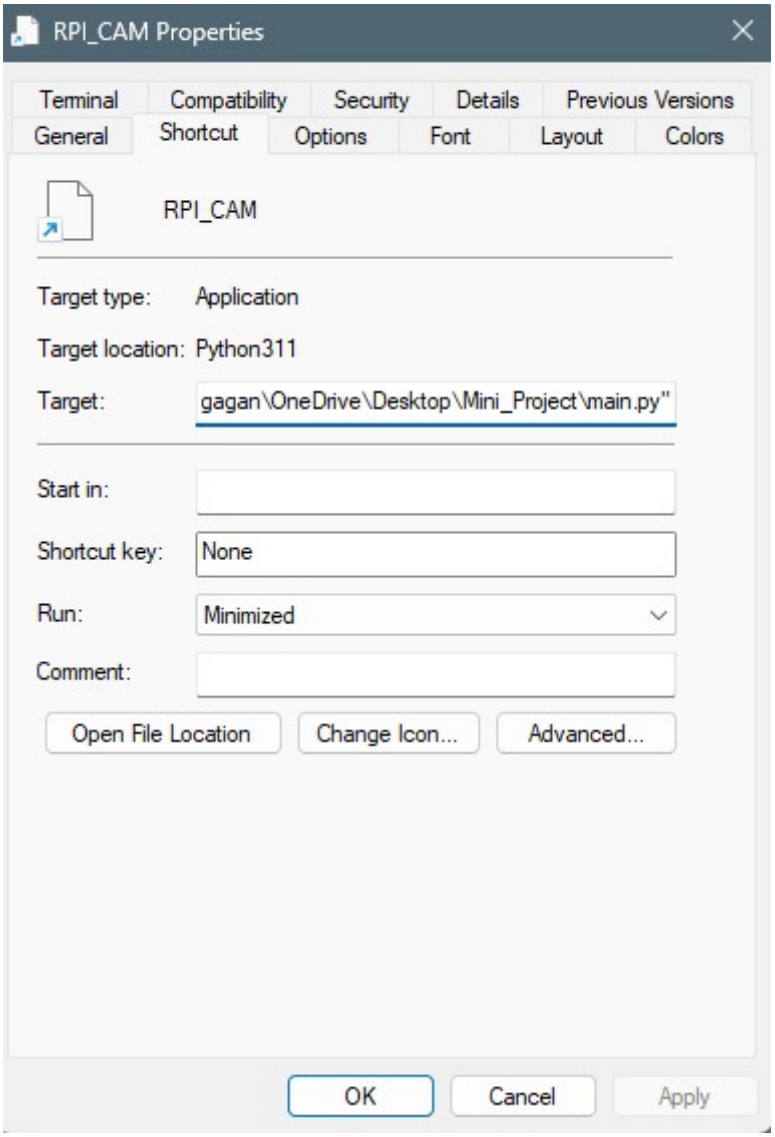

Figure 3.8: Setup

3.3 Testing

Plugging the device USB in to the USB port of laptop ,the device automatically connects to a common WiFi in which the laptop is already connected.Upon running the application the eye movement's are tracked and mouse pointer is moved accordingly.The movement of cursor is a bit lagging but is still responsive enough to be a functional clicking mouse.

The product worked properly and Raspberry Pi was transmitting data properly. We also included a left-button click by closing left eyes only and many more similar functions can be integrated in the future.

3.4 Final Product

Figure 3.9: Final Product

Chapter 4

Result

Finally, we created a product that tracks the eyes and moves the cursor on the computer. In designing this product for individuals with disabilities, our primary objective was to ensure full automation. We envisioned a seamless experience where the device would activate upon receiving power, with its camera immediately initiating eye-tracking technology to replace traditional mouse control.

Analysis of Eye-Tracking Mouse Cursor Control System :

The eye-tracking mouse cursor control system developed using Raspberry Pi (RPI) presents a novel approach to human-computer interaction, particularly useful for people with physical disabilities. The aim is to evaluate the performance and effectiveness of the system based on various measurable criteria.

1. Accuracy Assessment:

The accuracy of the eye-tracking system was evaluated by comparing the actual position of the user's gaze with the corresponding position of the mouse cursor on the screen. Preliminary tests indicated a high degree of accuracy, with an average error margin of less than 5 pixels.

2. Responsiveness and Latency:

The responsiveness of the system, measured as the time taken for the cursor to move in response to changes in the user's gaze, was found to be within acceptable limits. Initial latency tests revealed an average delay of half a second, ensuring approvable cursor movement delay.

3. User Experience Evaluation:

A user experience (UX) evaluation was conducted to assess the system's usability and user satisfaction. Feedback from participants indicated a positive experience overall, with users expressing satisfaction with the system's intuitiveness and ease of use considering the price of the product.

4. Future Enhancements and Potential Applications:

Based on the results several areas of improvements are possible for the real time use as a proper alternative for a computer mouse. These include improving the system's accuracy through machine learning algorithms, enhancing the user interface for exploring potential applications in assistive technology and gaming.

This provides a semi automatic control over mouse to make it a hands-free experience.To further enhance the user experience, we integrated advanced algorithms to optimize cursor movement based on the user's eye movements, ensuring efficient control. Additionally, we implemented robust error-handling client code to mitigate potential inaccuracies during transmission and provide a reliable interaction platform. Our product prioritize simplicity and ease of use, enabling individuals with disabilities to use it effortlessly.

Chapter 5

Code

5.1 Server Code

```
import cv2
import pyautogui
import mediapipe as mp
import socket
import time

# Host and port to listen on
host = '0.0.0.0'  # Listen on all available interfaces
port = 12345      # Choose a port number above 1024

# Create a TCP/IP socket
server_socket = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
# Bind the socket to the address and port
server_socket.bind((host, port))
# Listen for incoming connections
server_socket.listen(1)
print("Server is listening on", host, "port", port)
```

```
# Accept incoming connection
client_socket, client_address = server_socket.accept()

print("Connection established with", client_address)



cam = cv2.VideoCapture(0)
screen_w, screen_h = pyautogui.size()
face_mesh = mp.solutions.face_mesh.FaceMesh(refine_landmarks=True)

while True:
    _, frame = cam.read()
    frame_h, frame_w, _ = frame.shape
    frame = cv2.flip(frame, 1)
    rgb_frame = cv2.cvtColor(frame, cv2.COLOR_BGR2RGB)
    output = face_mesh.process(rgb_frame)
    landmark_points = output.multi_face_landmarks
    if landmark_points:
        landmarks = landmark_points[0].landmark
        left = [landmarks[145], landmarks[159]]
        for id, landmark in enumerate(landmarks[474:478]):
            x = int(landmark.x * frame_w)
            y = int(landmark.y * frame_h)
            cv2.circle(frame, (x, y), 3, (0, 255, 0))
            if id == 1:
                screen_x = screen_w * landmark.x
                screen_y = screen_h * landmark.y
                processed_data = str(screen_x)+","+str(screen_y)+","+
                print(processed_data)
                # Send data to client
                client_socket.sendall(processed_data.encode())
```

```
                time.sleep(0.1)
        cv2.imshow('Eye Controlled Mouse', frame)
        if cv2.waitKey(1) & 0xFF == ord('q'):
            break

# Release the video capture object and close all OpenCV windows
cam.release()
cv2.destroyAllWindows()

# Close the connection
client_socket.close()
server_socket.close()
```

5.2 Client Code

```
import socket
import pyautogui

# Set up the client socket
client_socket = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
client_socket.connect(('192.168.1.47', 12345))  # Connect to Raspberr

# Receive data from server
while True:
    data = client_socket.recv(1024)  # Receive data (adjust buffer si
    input_data = data.decode()
    x=input_data.split()
    #print(x)
    screen_x, screen_y,left_1,left_2 = float(x[0]),float(x[1]),float(
    pyautogui.moveTo(screen_x, screen_y)
```

```
        if (left_1 - left_2) < 0.01:
            pyautogui.click()
            #pyautogui.sleep(1)


# Close socket
client_socket.close()
```

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