AI Virtual Mouse

Submitted in partial fulfillment of the requirements of the degree

**BACHELOR OF ENGINEERING **

in

Computer Science and Engineering

(Artificial Intelligence & Machine Learning)

Sem - III

by

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(AY 2021-22)

CERTIFICATE

This is to certify that the Mini Project entitled **"AI Virtual Mouse"** is a bonafide work of **AIMLD03_ANSARI HANZALA MOHD IMAMUDDIN, AIMLD50_SINGH SUDHAM DHARMENDRA, AIMLD41_RUPARELIYA AKSHAR JAYANTI, AIMLD08_CHIKANKAR PRATHAMESH SHIVAJI** submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of **"Bachelor of Engineering"** in **"Computer Science and Engineering (Artificial Intelligence & Machine Learning)".**

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(Dr. Vivek Sunnapawar)
Principal

Mini Project Approval

This Mini Project entitled **“AI Virtual Mouse”** by **AIMLD03_ANSARI HANZALA MOHD IMAMUDDIN, AIMLD50_SINGH SUDHAM DHARMENDRA, AIMLD41_RUPARELIYA AKSHAR JAYANTI, AIMLD08_CHIKANKAR PRATHAMESH SHIVAJI** is approved for the degree of **Bachelor of Engineering** in **“Computer Science and Engineering (Artificial Intelligence & Machine Learning)”.**

Examiners

(Internal Examiner Name & Sign)

(External Examiner name & Sign)

Date: 11/12/2021

Place: Navi Mumbai

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We would like to say that it has indeed been a Fulfilling Experience for working out with this Project Topic.

Name of student

Hanzala Ansari Sudham Singh Prathamesh Chikankar Akshar Rupareliya

List of Abbreviations

AI : Artificial Intelligence

np : Numpy

cv2: Computer Vision 2

mp: MediaPipe

1. Introduction

1.1 Introduction

With the development of technologies in the areas of augmented reality and devices that we use in our daily life, these devices are becoming compact in the form of Bluetooth or wireless technologies. This paper proposes an AI virtual mouse system that makes use of the hand gestures and hand tip detection for performing mouse functions in the computer using computer vision. The main objective of the proposed system is to perform computer mouse cursor functions and scroll functions using a web camera or a built-in camera in the computer instead of using a traditional mouse device. Hand gesture and hand tip detection by using computer vision is used as a HCI with the computer. With the use of the AI virtual mouse system, we can track the fingertip of the hand gesture by using a built-in camera or web camera and perform the mouse cursor operations and scrolling function and also move the cursor with it.

In the proposed system, the web camera captures and then processes the frames that have been captured and then recognizes the various hand gestures and hand tip gestures and then performs the particular mouse function.

Python programming language is used for developing the AI virtual mouse system, and also, OpenCV which is the library for computer vision is used in the AI virtual mouse system. In the proposed AI virtual mouse system, the model makes use of the MediaPipe package for the tracking of the hands and for tracking of the tip of the hands, and also Autopy package were used for moving around the window screen of the computer for performing functions such as left click, right click, and scrolling functions. The results of the proposed model showed a very high accuracy level, and the proposed model can work very well in real-world application with the use of a CPU without the use of a GPU.

1.2 Motivation

- Create such application which introduce use of AI world in small manner

- Exploring vision-based interfaces is motivated by the unnaturalness of some of the conventional input devices such as mice and joysticks in many intelligent environments where intuitive interactions and teleoperations are required.

- It is fair to say that the Virtual Mouse will soon to be substituting the traditional physical mouse in the near future, as people are aiming towards the lifestyle where that every technological device can be controlled and interacted remotely without using any peripheral devices such as the remote, keyboards, etc. it doesn't just provide convenience, but it's cost effective as well.

- It is known in order to interact with the computer system, users are required to use an actual physical mouse, which also requires a certain area of surface to operate, not to mention that it suffers from cable length limitations.

- Virtual Mouse requires none of it, as it is only a webcam to allow image capturing of the user's hand position in order to determine the position of the pointers that the user wants it to be.

- The motivation is to create an object tracking application to interact with the computer, and develop a virtual human computer interaction device

1.3 Problem Statement & Objectives

Problem Statement:

- To design motion tracking mouse which detect finger movements gestures instead of physical mouse.
- To design an application (.exe file) with user friendly user interface which provides a feature for accessing motion tracking mouse feature.
- The camera should detect all the motions of the hand and perform the operation of the mouse.
- Implement such code where motion tracker mouse has drag & drop feature along with scrolling feature.
- User Interfaces must be Simple & easy to understand.
- Physical mouse requires special hardware and surface to operate.
- Implement such code where the camera can recognize each and every finger movement & responds according to it.

Objectives

- Create such an application which is part of AI.
- To design to operate with the help of a webcam.
- Users should be able to easily install it on their computer.
- To convert hand gesture/motion into mouse input that will be set to a particular screen position.
- Program should run as fast as possible without any lag.
- There should be no heavy tasks which can disturb the user.

2. Literature Survey

2.1 Survey of Existing System

The existing system consists of the generic mouse and trackpad system of monitor controlling and the nonavailability of a hand gesture system. The remote accessing of the monitor screen using the hand gesture is unavailable. Even-though it is largely trying to implement the scope is simply restricted in the field of virtual mouse. The existing virtual mouse control system consists of the simple mouse operations using the hand recognition system, where we could perform the basic mouse operation like mouse pointer control, left click, right click, drag etc. The further use of the hand recognition has not been made use of. Even Though there are a number of systems which are used for hand recognition, the system they made is the static hand recognition which is simply recognition of the shape made by hand and by defining an action for each shape made, which is limited to a number of defined actions and a large amount of confusion.

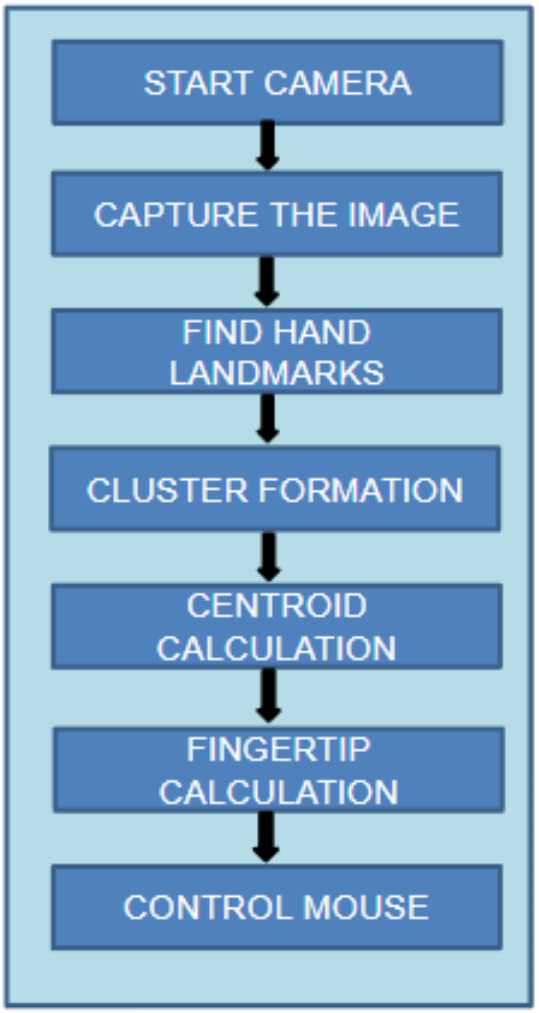
In this pandemic era it is not safe to use the devices by touching them because it may result in a possible situation of spread of the virus by touching the devices, so the proposed AI virtual mouse can be used to control the PC mouse functions without using the physical mouse.

2.2 Limitation Existing system or research gap

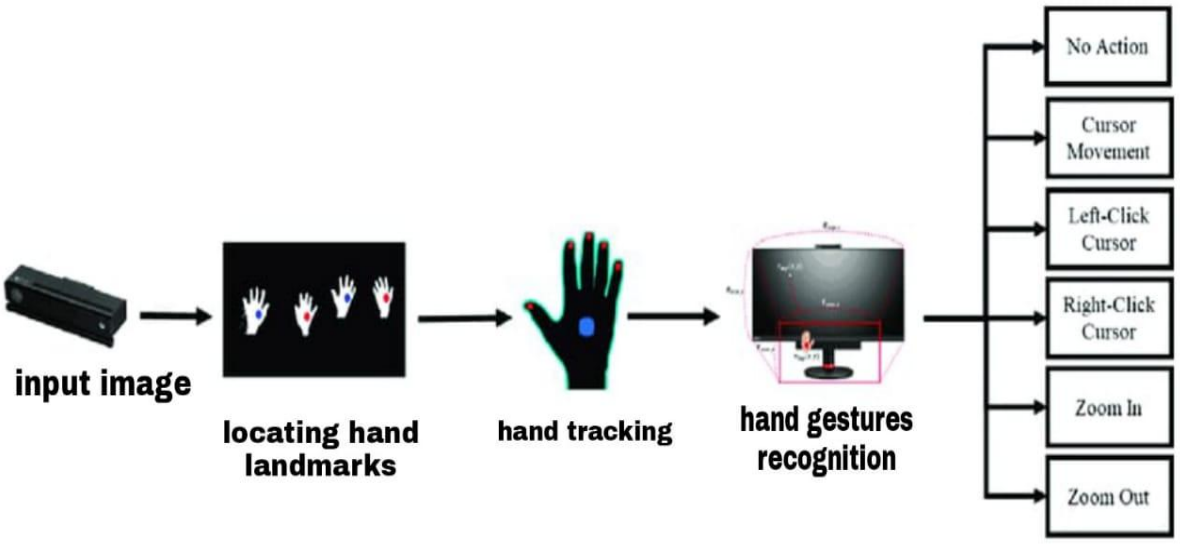
- Existing mouse needs a flat surface close to the computer.
- Older style mouse which have roller balls can become clogged with grease and grime and lose their accuracy until cleaned.
- Excessive use can lead to health problems such as repetitive strain injury (R.S.I.)
- If the battery wears out in a wireless mouse, it cannot be used until it has been replaced.
- Physical mouse is not easily adaptable to different environments and its performance varies depending on the environment.

3. Proposed System (eg. New Approach of Data Summarization)

3.1 Algorithm and Process Design



Algorithm



Process Design

3.2 Details of Software

- **Python:**

Python is an interpreted high-level general-purpose programming language. Its design philosophy emphasizes code readability with its use of significant indentation. Its language constructs as well as its object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects.

The reason for choosing Python as a programming language, because it is easy to understand and also a dynamically typed language, and also it has a lot of libraries and frameworks that are compatible with python language. The python language is one of the most accessible programming languages available because it has simplified syntax and is not complicated, which gives more emphasis on natural language.

- **OpenCV:**

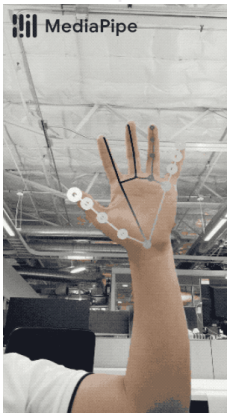
OpenCV is a computer vision library which contains image-processing algorithms for object detection. OpenCV is a library of python programming language, and real-time computer vision applications can be developed by using the computer vision library. The OpenCV library is used in image and video processing and also analysis such as hand detection and object detection.

- **MediaPipe:**

Live ML anywhere

MediaPipe offers cross-platform, customizable ML solutions for live and streaming media.

End-to-End acceleration: *Built-in fast ML inference and processing accelerated even on common hardware*	*Build once, deploy anywhere*: *Unified solution works across Android, iOS, desktop/cloud, web and IoT*
Ready-to-use solutions: *Cutting-edge ML solutions demonstrating full power of the framework*	*Free and open source*: *Framework and solutions both under Apache 2.0, fully extensible and customizable*

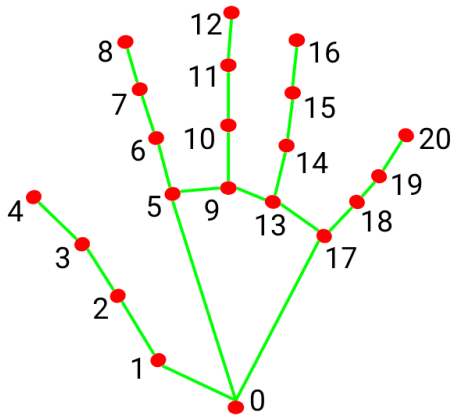


Tracked 3D hand landmarks are represented by dots in different shades, with the brighter ones denoting landmarks closer to the camera.

Hand Landmark Model

After the palm detection over the whole image our subsequent hand landmark model performs precise keypoint localization of 21 3D hand-knuckle coordinates inside the detected hand regions via regression, that is direct coordinate prediction. The model learns a consistent internal hand pose representation and is robust even to partially visible hands and self-occlusions.

To obtain ground truth data, we have manually annotated ~30K real-world images with 21 3D coordinates, as shown below (we take Z-value from image depth map, if it exists per corresponding coordinate). To better cover the possible hand poses and provide additional supervision on the nature of hand geometry, we also render a high-quality synthetic hand model over various backgrounds and map it to the corresponding 3D coordinates.



0. WRIST
1. THUMB_CMC
2. THUMB_MCP
3. THUMB_IP
4. THUMB_TIP
5. INDEX_FINGER_MCP
6. INDEX_FINGER_PIP
7. INDEX_FINGER_DIP
8. INDEX_FINGER_TIP
9. MIDDLE_FINGER_MCP
10. MIDDLE_FINGER_PIP
11. MIDDLE_FINGER_DI
12. MIDDLE_FINGER_TI
13. RING_FINGER_MCP
14. RING_FINGER_PIP
15. RING_FINGER_DIP
16. RING_FINGER_TIP
17. PINKY_MCP
18. PINKY_PIP
19. PINKY_DIP
20. PINKY_TIP

Hand Landmarks extracted by MediaPipe

- **AutoPy:**

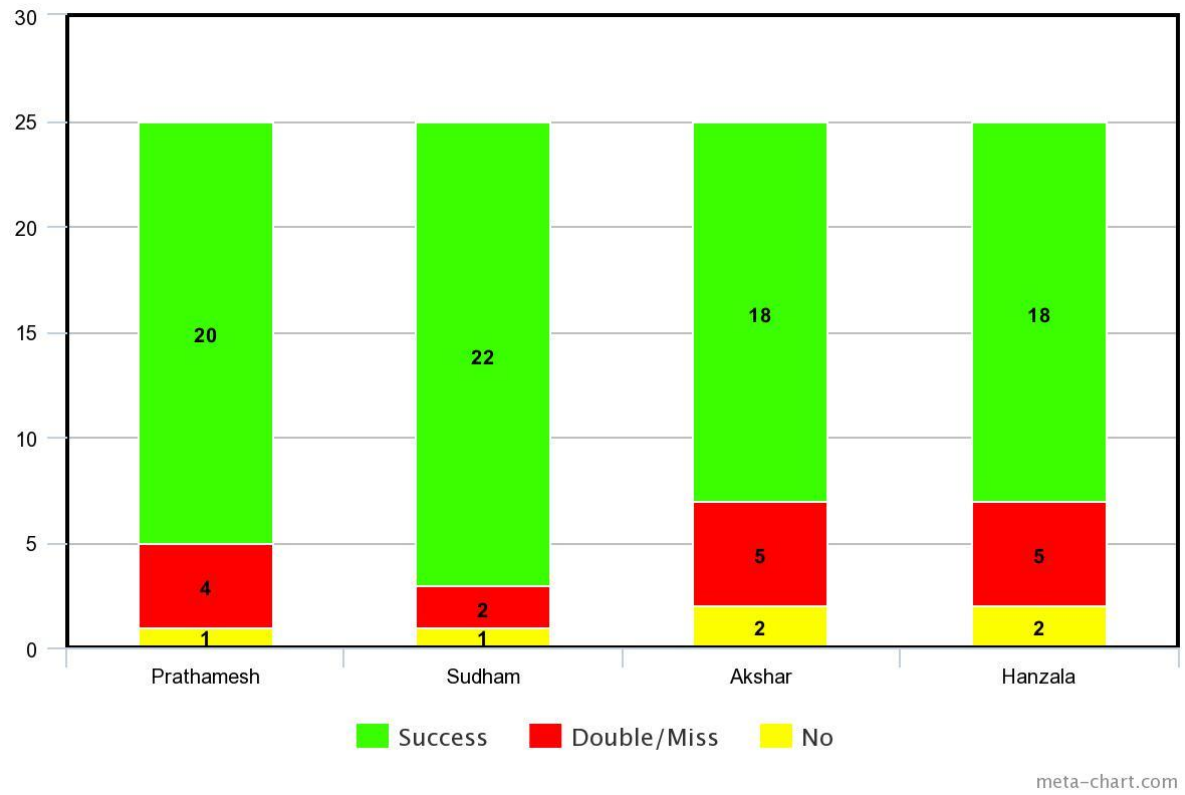
AutoPy is a cross-platform, simple GUI automation toolkit for Python. It includes functions for controlling the keyboard and mouse, finding colors and bitmaps on-screen, and displaying alerts — all in a cross-platform, efficient, and simple manner.

- **NumPy:**

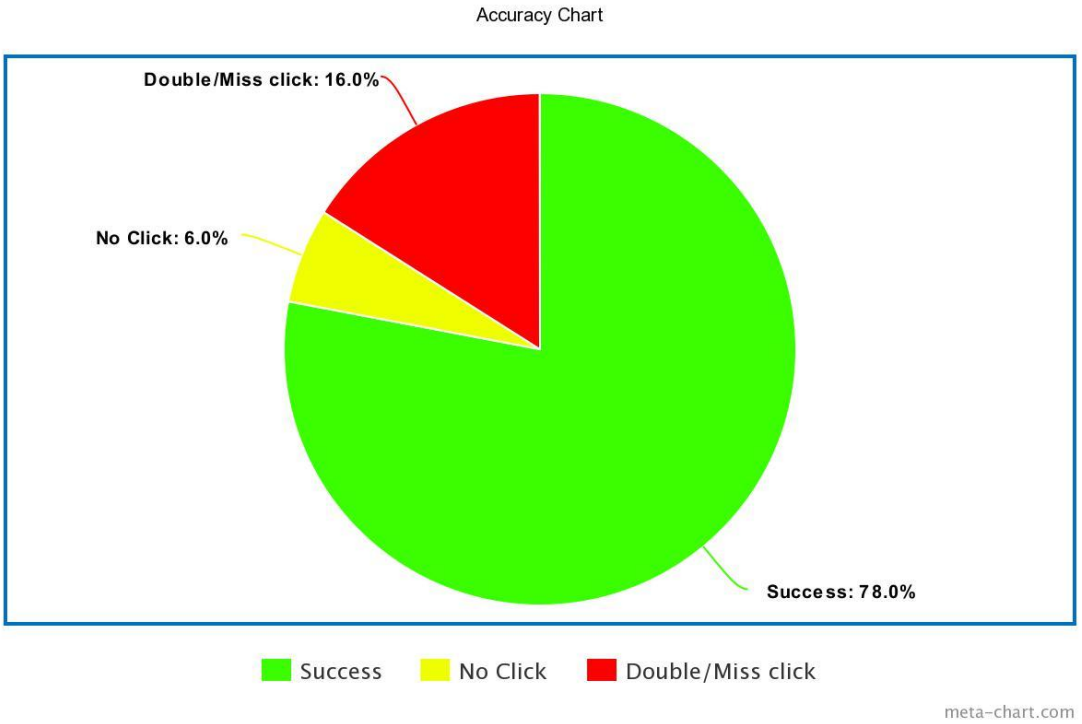
NumPy is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays. The ancestor of NumPy, Numeric, was originally created by Jim Hugunin with contributions from several other developers. In 2005, Travis Oliphant created NumPy by incorporating features of the competing Numarray into Numeric, with extensive modifications. NumPy is open-source software and has many contributors. NumPy is a NumFOCUS fiscally sponsored project.

3.3 Experiment and Results

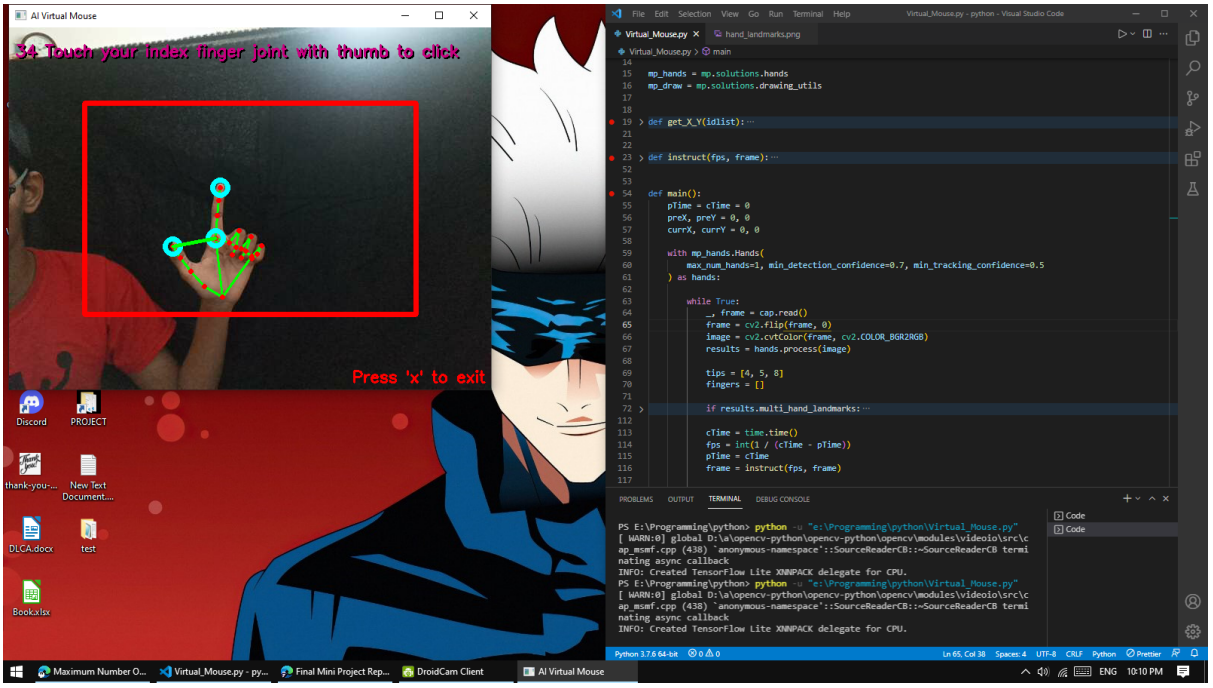
Cross comparison of the testing of the AI virtual mouse system is difficult because only limited numbers of datasets are available. The hand gestures and fingertip detection have been tested in various illumination conditions and also been tested with different distances from the webcam for tracking of the hand gesture and hand tip detection. An experimental test has been conducted to summarize the results shown in Graph. The test was performed 25 times by 4 persons resulting in 100 gestures with manual labelling, and this test has been made in different light conditions and at different distances from the screen, and each person tested the AI virtual mouse system 10 times in normal light conditions, 5 times in faint light conditions, 5 times in close distance from the webcam, and 5 times in long distance from the webcam, and the experimental results in Graph.



Accuracy of each member



Accuracy Chart



Execution image

3.4 Conclusion and Future work.

- **Conclusion:**

The main objective of the AI virtual mouse system is to control the mouse cursor functions by using the hand gestures instead of using a physical mouse. The proposed system can be achieved by using a webcam or a built-in camera which detects the hand gestures and hand tip and processes these frames to perform the particular mouse functions.

From the results of the model, we can come to a conclusion that the proposed AI virtual mouse system has performed very well and has a greater accuracy compared to the existing models and also the model overcomes most of the limitations of the existing systems. Since the proposed model has greater accuracy, the AI virtual mouse can be used for real-world applications, and also, it can be used to reduce the spread of COVID-19, since the proposed mouse system can be used virtually using hand gestures without using the traditional physical mouse.

- **Future work:**

In upcoming semesters we are planning to train our model better and add more features to it, such as resizing windows and drag and drop functionalities and at this point of time we will be able to use or browse any application or website without touching our physical mouse.

Smart Movement: Due to the current recognition process being limited within 50cm radius, an adaptive zoom in/out functions are required to improve the covered distance, where it can automatically adjust the focus rate based on the distance between the users and the webcam.

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