PANIMALAR
ENGINEERING COLLEGE
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PROGRESS THROUGH KNOWLEDGE

Department of Computer Science and Engineering

GESTURE MATE

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Introduction

The paper proposes an AI virtual mouse system that utilizes hand gestures and hand tip detection for performing mouse functions on a computer using computer vision. The system aims to replace traditional mouse devices by using a built-in camera or webcam to track fingertip movement and perform mouse cursor operations and scrolling functions. Python programming language and OpenCV library are used in the system, along with MediaPipe, Pynput, Autopy, and PyAutoGUI packages. The proposed model achieves high accuracy levels and can work well in real-world applications without the use of a GPU.

Objective of the Project

Using the current system even-though there are a number of quick access methods available for the hand and mouse gesture for the laptops, using our project we could make use of the laptop or web-cam and by recognizing the hand gesture we could control mouse and perform basic operations like mouse pointer controlling, select and deselect using left click, and a quick access feature for file transfer between the systems connected via network LAN cable. The project done is a “Zero Cost” hand recognition system for laptops, which uses simple algorithms to determine the hand, hand movements and by assigning an action for each movement. But we have mainly concentrated on the mouse pointing and clicking actions along with an action for the file transfer between connected systems by hand action and the movements.

Literature Survey

S. No	Title	Journal Name, Author and Year	Methodology	Objective	Merits	Demerits
1	Design and implementation of a gesture-controlled virtual mouse system	Journal of Information Science and Engineering, Y. Lin and C. Tseng (2014)	Optical flow-based hand tracking and neural network-based gesture recognition	To develop a virtual mouse system that recognizes hand gestures to control the mouse pointer	Accurate recognition of hand gestures, simple user interface	Limited to 2D hand gestures and requires a camera with high frame rate
2	A framework for gesture-based virtual mouse control using depth data	Computer Vision and Image Understanding, M. Mustafa and S. Iqbal (2019)	Depth-based hand tracking and gesture recognition using decision tree algorithm	To develop a virtual mouse system that recognizes hand gestures in 3D space	Accurate recognition of hand gestures in 3D space, works with low-resolution cameras	Limited to predefined gestures and requires significant computational resources

Literature Survey

3	Hand gesture recognition-based virtual mouse	International Journal of Computer Science and Information Technologies, S. P. Biswas et al. (2018)	Skin color-based hand detection and template matching-based gesture recognition	To develop a low-cost virtual mouse system that recognizes hand gestures in real-time	Low-cost and real-time gesture recognition, works with low-resolution cameras	Limited to predefined gestures and may be affected by changes in lighting conditions
4	A comparison of hand gesture recognition techniques for virtual mouse control	International Journal of Human-Computer Interaction, A. Alsaffar and H. Yousif (2017)	Feature-based, template-based, and neural network-based gesture recognition techniques	To compare the accuracy and efficiency of different gesture recognition techniques for virtual mouse control	Comparative analysis of different gesture recognition techniques, identifies limitations of each technique	Limited to predefined gestures and may require significant computational resources depending on the technique

Literature Survey

5	"Real Time Virtual Mouse Control using Hand Gesture Recognition"	International Journal of Innovative Research in Computer and Communication Engineering, K. M. Kavitha et al. (2017)	Experimental	To develop a real-time hand gesture recognition system for virtual mouse control	Uses a camera to capture hand gestures and a neural network for classification	Limited to a specific type of neural network
6	"A Review of Human-Computer Interaction Techniques using Hand Gesture Recognition"	International Journal of Advanced Research in Computer Science and Software Engineering, S. B. Gupta et al. (2017)	Literature review	To review different hand gesture recognition techniques and their applications in HCI	Provides a comprehensive review of different techniques and their limitations	Does not focus specifically on gesture-controlled virtual mouse systems

Problem Statement

- Traditional methods of controlling slides, such as using a physical mouse or keyboard, can be cumbersome and distracting for the presenter.
- Gesture control technology can provide a more intuitive and seamless way to navigate through slides during presentations.
- Current gesture control technology can be expensive and not accessible to everyone.
- The development of an affordable and user-friendly gesture-controlled virtual mouse for slide presentations would improve the overall user experience.
- The final product should be easy to set up and use, with clear instructions and minimal technical requirements.

Proposed System

1. The user activates the system by voice command, such as "Start Virtual Mouse".
2. The system initializes and waits for hand gesture input and voice commands from the user.
3. The gesture recognition software analyzes the camera feed to detect the user's hand gestures.
4. The virtual mouse software translates the user's hand gestures into mouse movement commands.
5. The system updates the position of the virtual mouse on the computer screen based on the user's hand gestures.
6. The voice recognition software listens for voice commands from the user.

Proposed System

7. The system processes the voice commands and performs the corresponding actions, such as clicking, scrolling, or opening applications.

8. The system continues to track hand gestures and listen for voice commands until the user deactivates the system by voice command, such as "Stop Virtual Mouse".

Software / Hardware used

HardWare:

1. Webcam
2. laptop or Pc

Software:

1.Python

2.Anaconda

3. VS code

4. Javascript

Architecture / Methodology used

1. Hardware: A laptop or desktop computer with a built-in or external webcam for capturing hand gestures.
2. Software: The system would consist of several software components:

   a. Image processing software: This component would be responsible for capturing and processing images from the webcam, isolating the hand region, and segmenting the hand from the background.

   b. Gesture recognition software: This component would analyze the segmented hand region and identify hand gestures using machine learning or computer vision algorithms.

   c. Virtual mouse software: This component would translate the detected hand gestures into mouse movements, clicks, and other actions. It would also include features such as cursor speed and sensitivity control, and left/right-hand switching.

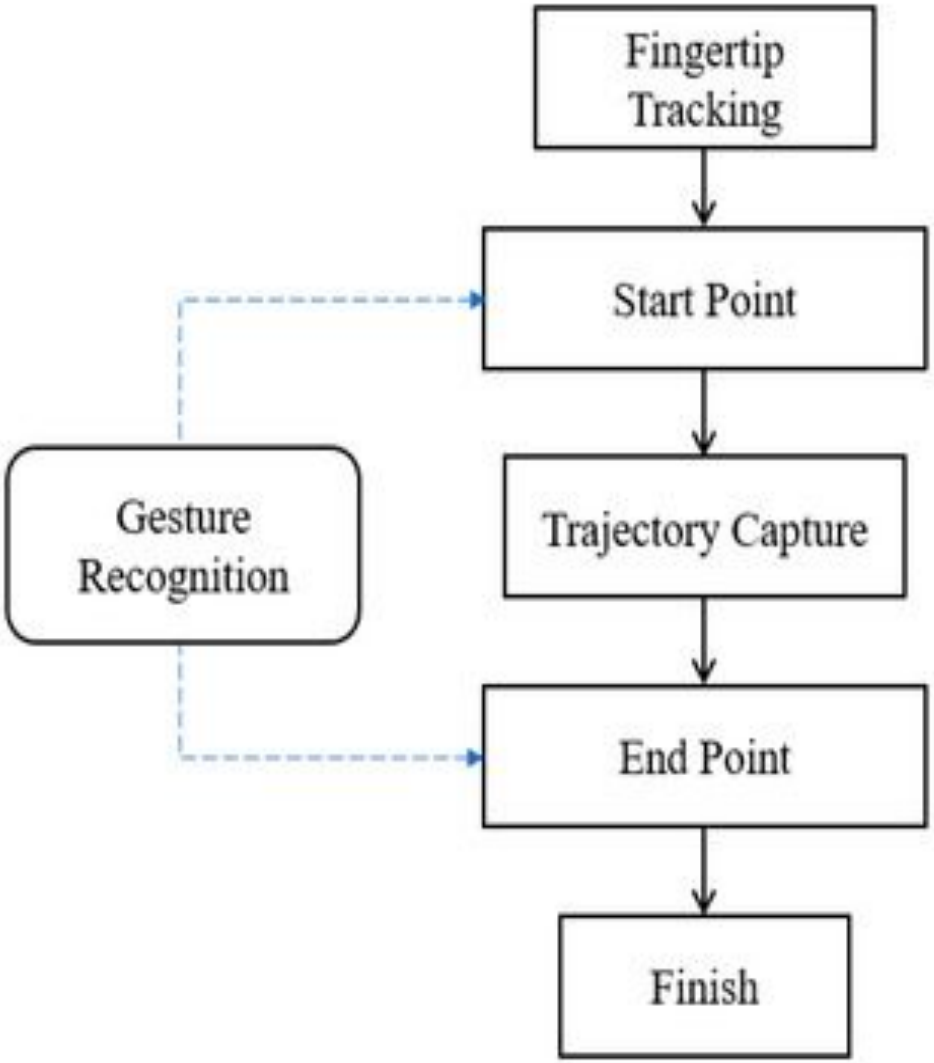
Architecture / Methodology used

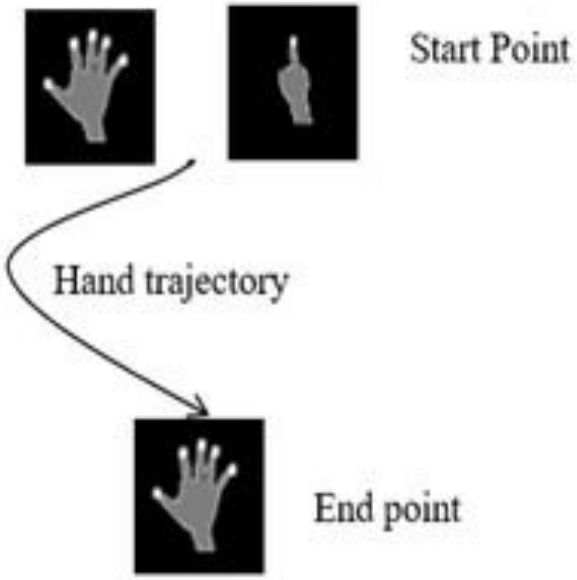
3. User Interface: The system would have a simple and intuitive user interface that allows users to control the virtual mouse using their hand gestures. The user interface would also allow users to customize the gesture recognition parameters and virtual mouse settings to suit their preferences.

4. Networking: The system could include networking capabilities to enable file transfer between connected systems via LAN cable.

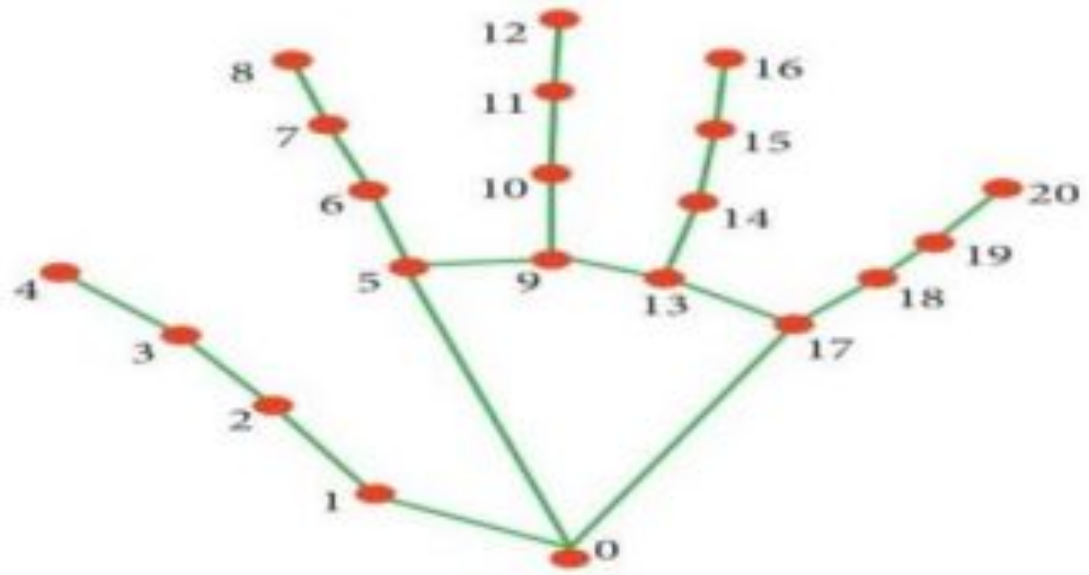
Overall, this allows users to control their computer using simple hand gestures, providing a more natural and ergonomic way of interacting with their computer. The system would be flexible and customizable, allowing users to adjust the settings to meet their specific needs.

System Design - UML diagram





System Design - Modular diagram:



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_DIP
12. MIDDLE_FINGER_TIP
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

System Design - Use case diagram:

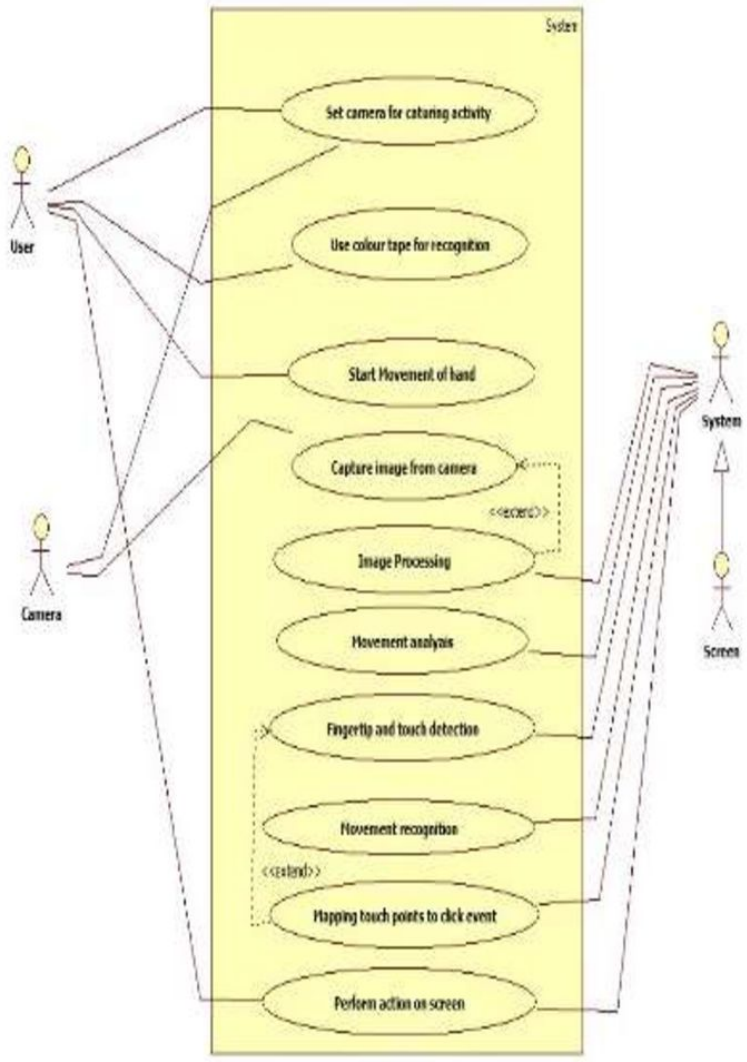


Fig. 2: Use Case

Module Description

Gesture Recognition Module:

This module is responsible for recognizing the gestures made by the user. The module uses sensors or cameras to capture the hand movements of the user, and then processes the data to identify the intended gesture.

Mapping Module:

This module maps the recognized gesture to a corresponding action. For example, a specific gesture may be mapped to the action of moving the cursor up or down, left or right. Cursor Control Module: This module takes the actions identified by the mapping module and controls the movement of the cursor accordingly. It may use algorithms such as the Kalman filter to smooth out the cursor movement and improve accuracy.

Module Description

Click Control Module:

This module is responsible for detecting the user's intention to click or double-click. It may use a variety of techniques such as analyzing the hand movement speed, time between clicks, or finger positions to determine the intended action.

Feedback Module:

This module provides feedback to the user to indicate that their actions have been recognized and executed correctly. It may use visual or auditory cues such as sound effects or cursor changes to provide feedback.

Module Description

User Interface Module:

This module provides a graphical user interface for the user to interact with the system. It may display the current cursor position, provide options for adjusting sensitivity or gesture recognition settings, or allow the user to switch between different modes of operation.

Overall, the gesture-controlled virtual mouse system works by capturing the user's hand movements, recognizing the intended gesture, mapping it to a corresponding action, and then controlling the cursor accordingly. The system provides feedback to the user to indicate that their actions have been recognized and executed correctly

Testing /Performance Evaluation / Results

An AI system utilizing computer vision to improve human-computer interaction is proposed in the proposed visual mouse AI system. Because of the limited number of data sets available, it is difficult to compare contradictory outcomes of testing of visual AI mouse systems. A total of 600 hand-labeled touches were obtained through this test, which was performed 25 times by four people in different lighting conditions and at different distances from the screen, and each person tested the visual mouse system individually. In Table 1, the results of 10 AI tests performed in normal light conditions, 5 AI tests performed in dim light, 5 AI tests performed near the webcam, and 5 AI tests performed at a distance from the webcam are tabulated.

Testing /Performance Evaluation / Results

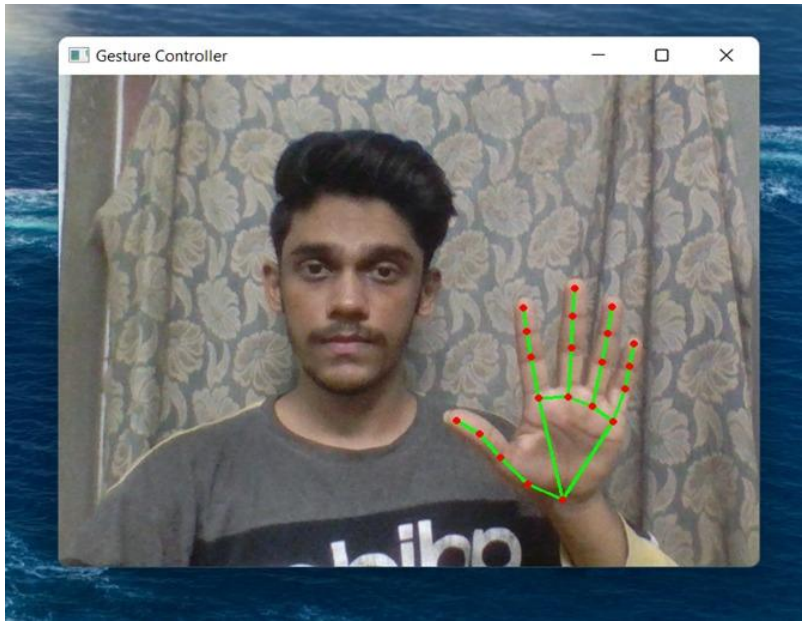
Table 1: Experimental results.

Hand tip gesture *	Mouse function performed	Accuracy (%)	Success	Failure	
Tip ID 1 or both tip IDs 1 and 2 are up	Mouse movement	100	0	1(	
Tip IDs 0 and 1 are up and the distance between the fingers is <30	**Left button click**	99	1	9	
Tip IDs 1 and 2 are up and the distance between the fingers is <40	**Right button click**	95	5	9	
Tip IDs 1 and 2 are up and the distance between the fingers is >40 and both fingers are moved up the page	Scroll up function	100	0	1(	
Tip IDs 1 and 2 are up and the distancebetween the fingers is >40 and both fingers 100 are moved down the page	Scroll down function		100	0	
All five tip IDs 0, 1, 2, 3, and 4 are up	No action performed	100	0	1	
Result		594	6	9	

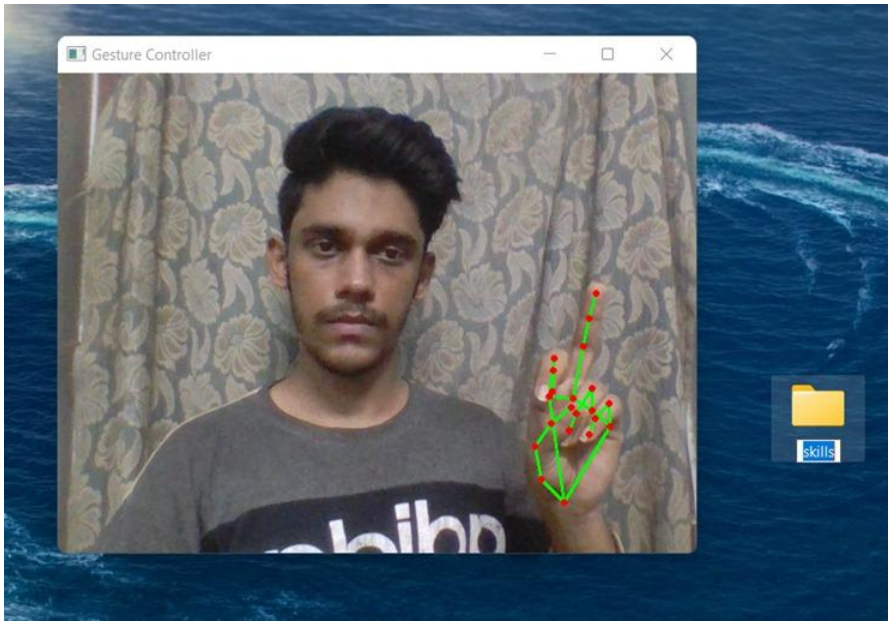
*Finger tip ID for respective fingers: tip Id 0: thumb finger; tip Id 1: index finger; tip Id 2: middle finger; tip Id 3: ring finger; tip Id 4: little finger.

Screen Shots

Neutral Gesture:

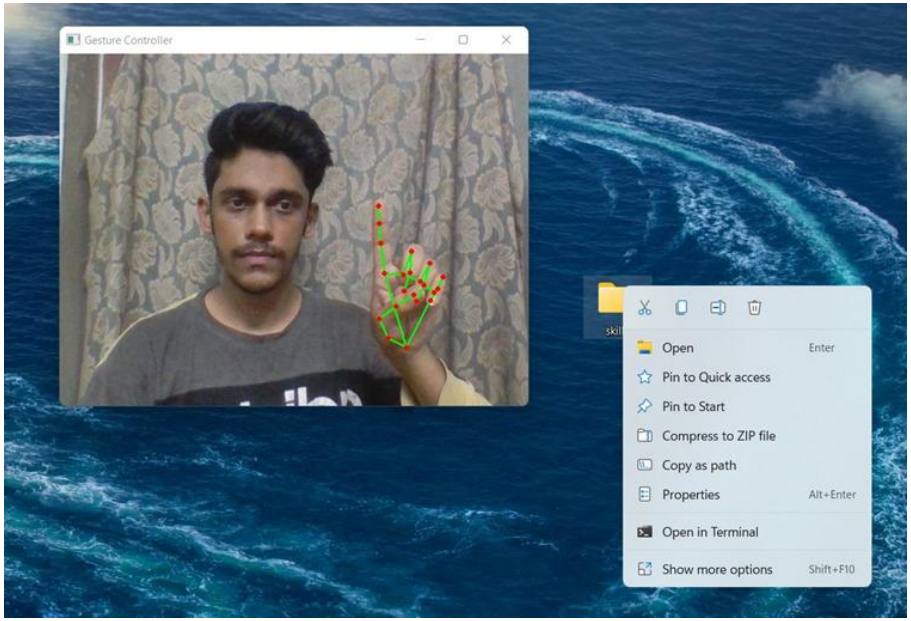


Left Click:

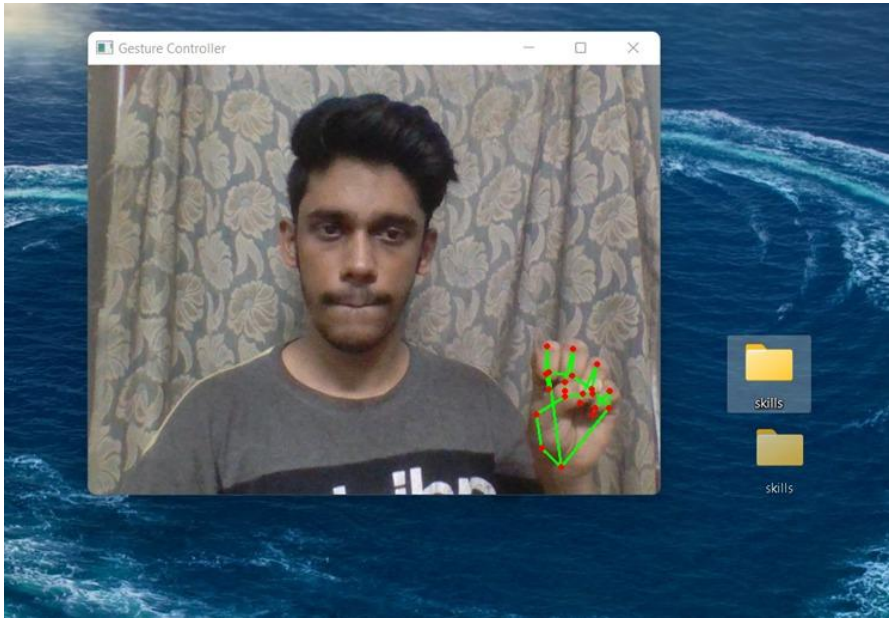


Screen Shots

Right Click:



Drag and Drop:



Conclusion / Feature Enhancement

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.

The model has some limitations such as small decrease in accuracy in right click mouse function and some difficulties in clicking and dragging to select the text. Hence, we will work next to overcome these limitations by improving the finger tip detection algorithm to produce more accurate results.

Reference Paper/ URL

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