RESEARCH ARTICLE OPEN ACCESS

HandyPresenter- An Integrated Virtual Interaction Suite

Sumimol L [1], Sneha G S [2], Vaishnavi P [3], Vinaya Nair [4], Theertha Sreekumar [5]

[1]Assistant Professor, Department of Computer Science and Engineering, LBSITW, Trivandrum
[2,3,4,5]U. G Scholars, Department of Computer Science and Engineering, LBSITW, Trivandrum

ABSTRACT
Traditional computer mouse long served as indispensable external hardware components for HCI, anchoring the way we navigate and input information into digital systems. HandyPresenter is an all-in-one gesture control system featuring a virtual mouse, virtual keyboard, and virtual painter. The Virtual Mouse navigates through the system and has a double-click functionality, controlled using fingers. Users can also navigate PowerPoint presentations smoothly using hand gestures for slide navigation. The system utilizes a webcam to accurately detect and interpret the movements and gestures of the user's palm in three-dimensional space, providing precise cursor movement and comprehensive control over desktop applications and system functions. Additionally, the system includes a virtual keyboard and a virtual painter activated by their respective gesture recognition. The virtual keyboard offers efficient text entry into any software, and users can conveniently position it by moving the keyboard across the screen. The virtual painter equips the presenter with different colored brushes and an eraser, serving as a versatile tool to deliver engaging and interactive content to the audience. The system thereby offers presenters a presentation-friendly interface using hand gestures, allowing them to control slide, type, and virtually paint without ever needing to touch the computer itself.

I. INTRODUCTION

In the ever-evolving landscape of Human-Computer Interaction (HCI), our groundbreaking project emerges as a beacon of innovation, transcending the boundaries of traditional input devices. At its core, this project pioneers a new era by introducing an intuitive and immersive system that responds to dynamic finger gestures, revolutionizing the way users interact with digital interfaces.

Through virtual mouse navigation, gesture-controlled presentations, and a virtual keyboard and a painter, our platform offers unprecedented control and accessibility. HandyPresenter's virtual mouse lets you control your cursor with intuitive hand gestures. Seamlessly integrating intuitive finger gestures captured by a webcam, users navigate applications with precision. Gesture-controlled presentations captivate the audience with effortless slide transitions using natural hand gestures. Furthermore, our virtual keyboard pops up at a gesture command, allowing one to type with ease directly in the air. Virtual painter empowers users to unleash creativity digitally with ease This project epitomizes a paradigm shift in HCI, setting a new standard for user-centric digital experiences. HandyPresenter frees presenters from the constraints of a physical workspace, allowing them to move around naturally and connect more dynamically with their audience. This innovative system eliminates the need to switch between tools, streamlining the presentation flow and keeping the focus on the content and the presenter's delivery. HandyPresenter empowers presenters with a more intuitive and engaging way to interact with their presentations, fostering a richer and more interactive experience for both the presenter and the audience.

Aim and objective include:

- It provides users with a more natural and engaging way to navigate digital content.
- It provides valuable assistance to lecturers during presentations.
- It enhances productivity, especially in the field of design and modeling.
- It plays a vital role in promoting a hygienic and safe environment, especially during the pandemic.

II. EXISTING SYSTEM

The paper "Smart Presentation Control by Hand Gestures Using Computer Vision and Google's MediaPipe"[1] introduces a system for controlling presentations with hand gestures. This system uses Google's MediaPipe and TensorFlow. This system allows presenters to interact with slides. This allows slide navigation and to use pointer on the slide using hand gestures. However, this is limited within the slides, and using TensorFlow can increase the execution time.

The paper "Virtual Mouse with Hand Gestures Using AI"[3] presents a system for real-time AI virtual mouse control, enabling users to interact with computers without physical input devices. This system uses the Mediapipe and OpenCV for hand detection and autopsy to track finger movement and to perform left click and right click. This project has shown an accuracy of over 98%.

The paper " Hand Gesture Recognition based Virtual Mouse using CNN "[4] describes a system for hand gesture recognition using a Convolutional neural network. This deep learning-based system uses 9000 images custom dataset. A sequential CNN model was employed, featuring 4 Conv2D

layers with filters ranging from 32 to 256, kernel size (3, 3), stride 2, and pool size (2, 2). The input size was set to (64, 64, 3), and the activation function used was ReLU. Data augmentation was performed using a model ImageDataGenerator, and this included 6 dense layers after a flattened layer to connect the convolutional and dense layers.The final output layer uses SoftMax activation for classifying 6 different gestures. Regarding accuracy, one project reported a training accuracy of 96.875% and a testing accuracy of 87.5%.

The author of the paper “Mouse on a Ring: A Mouse Action Scheme BASED on IMU and Multi-Level Decision Algorithm” [6] utilizes a smart ring worn on the middle finger of the user’s right hand. This ring is equipped with IMU sensors that capture changes in the finger’s attitude angle, which correspond to the cursor position changes on the screen. Additionally, the system detects rapid rotations of the user’s palm to the left and right to simulate mouse clicks. A significant part of the methodology is the multi-level decision algorithm developed to enhance the response speed and recognition accuracy of the virtual mouse. This algorithm processes the sensor data to distinguish between intentional cursor movements and clicks from non-intentional hand gestures. The experimental results reported in the paper indicate that the virtual mouse achieves a target selection accuracy of over 96%.

The paper "Hand Gesture Recognition Using OpenCV" [5] describes a system for hand gesture recognition using OpenCV and Mediapipe. The system is used to detect the palm and display landmarks on the palm. Once that is revealed, it detects some simple hand gestures. This forms the base of our project detecting the hand gesture and performing the corresponding task.

The authors of the paper “HandKey: An Efficient Hand Typing Recognition using CNN for Virtual Keyboard” [8] propose a method that does not require additional equipment or prior experience from users. It simulates regular typing actions in the air, akin to typing on a real QWERTY keyboard. The core of the methodology is the use of Convolutional Neural Networks to classify hand typing gestures. Specifically, the CNN model is trained to recognize two types of gestures: ‘touch’ and ‘non-touch’. Additionally, the model is trained on 11 gestures corresponding to non-touch and touching actions for each of the ten fingers across both hands. The proposed CNN model achieved remarkable accuracy rates. For the two-gesture case (touch and non-touch), the model reached a classification accuracy of 99.2%. For the more complex 11-gesture case, the accuracy was 91%.

The paper “The Virtual Keyboard Based on Finger Recognition” [7] employs a combination of computer vision and machine learning to interpret real-time finger movements within a defined space. The system identifies finger position, orientation, and gestures, mapping them to corresponding keyboard inputs. It integrates biometric authentication through unique finger patterns to enhance security. The system uses OpenCV and TensorFlow. The system is designed to perform robustly under varying lighting conditions, ensuring a high degree of accuracy in recognizing finger movements and translating them into keyboard actions.

The paper " AI Virtual Painter Using OpenCV and Mediapipe" [10] uses a webcam to capture real-time video data, with the MediaPipe library detecting hand points and gestures. When the index and middle fingers are open, it indicates the selection mode, allowing the user to choose colors. With only the index finger open, the system enters drawing mode, enabling the user to draw on the screen1. The system tracks hand movements to create designs or written content, effectively translating gestures into digital art or text. The accuracy is said to be 98.48%

III. METHODOLOGY

The proposed system introduces an innovative interface where users control various functions through finger movements in the air. With gestures assigned to specific actions like cursor movement, clicking, typing, and drawing, users interact with digital elements without physically touching any hardware. This hands-free approach offers an intuitive and seamless user experience, enhancing accessibility and convenience across different tasks and applications. The hand gestures are set for calling each module such that all left-palm fingers are always raised (indicating the command mode) and the right-hand gesture varies (indicating the operation mode). Thereby we can have the cursor under our hand at any time by just showing its gesture in front of the camera. Following is the overall algorithm:

1. Start
2. On raising the left-hand fingers and index finger of the right hand the Access of cursor movement is under our index finger. The index and middle finger for double-tap to perform the selection operation.
3. On raising all left-hand fingers and index and middle finger of the right hand, the PowerPoint Presentation is launched in slideshow, and slide navigation is performed by raising the left hand or right-hand thumb for the next and previous slides respectively.
4. Raising all five left-hand fingers and right-hand index, middle, and ring fingers, the Virtual keyboard is popped up. Using the index finger to point to a letter and, the index and middle finger to select the letter, the typing operation is performed. The position of the keyboard can also be moved to a convenient position.
5. The virtual painter is opened by raising all fingers of the left hand and four right-hand fingers - index, middle, ring, and pinkie fingers symbolizing a brush. Double tap on a brush, and start drawing in the air to display on the white canvas. An eraser button is also present.
6. Steps 2- 5 are continued until we Stop the execution.

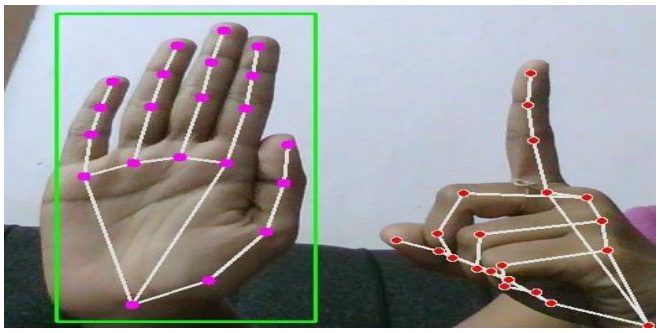

Fig. 1 Gesture for Activating Virtual Mouse Navigation

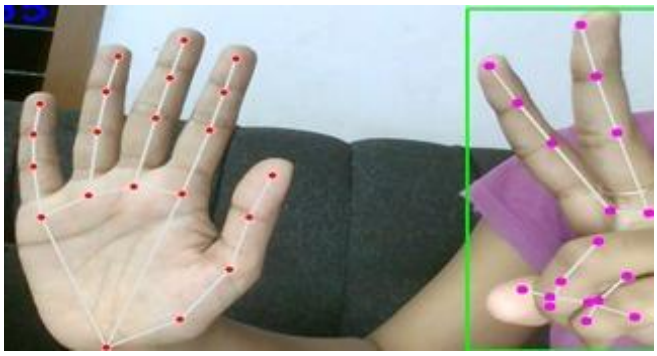

Fig. 2 Gesture for Activating PowerPoint Presentation

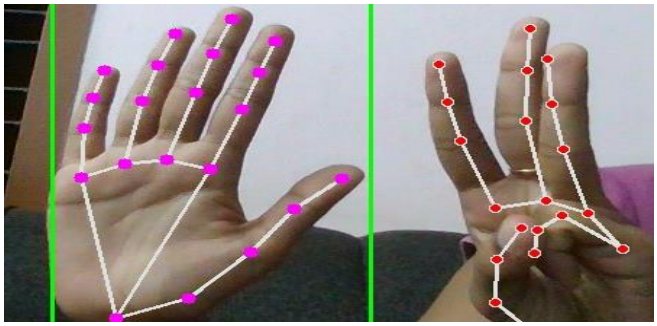

Fig. 3 Gesture for Activating Virtual Keyboard

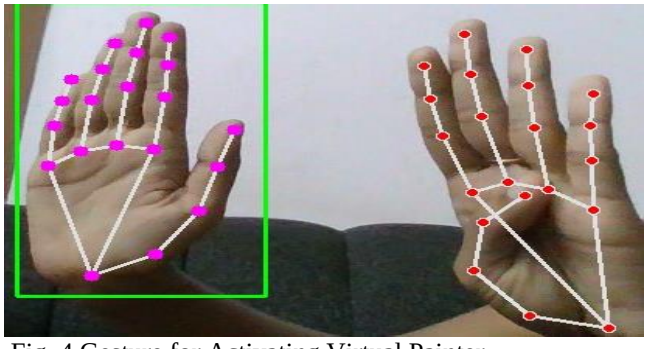

Fig. 4 Gesture for Activating Virtual Painter

A. Hand Tracking Module

This utilizes the MediaPipe library to detect and track hand gestures and movements in an image. It provides functionalities to find hands, locate landmarks on the hand, calculate distances between landmarks, and determine the status of fingers. This hand detection and tracking module is used in all the following modules enabling users to interact with digital interfaces using hand gestures and movements. The algorithm is as follows:

1. Start the video capture.
2. Continuously read frames from the camera.
3. Use the hand detector to find and draw landmarks on hands in each frame.
4. Retrieve the positions of the fingertips and other landmarks.
5. Display the frame with annotations
6. Continue this process until the user exits the program.

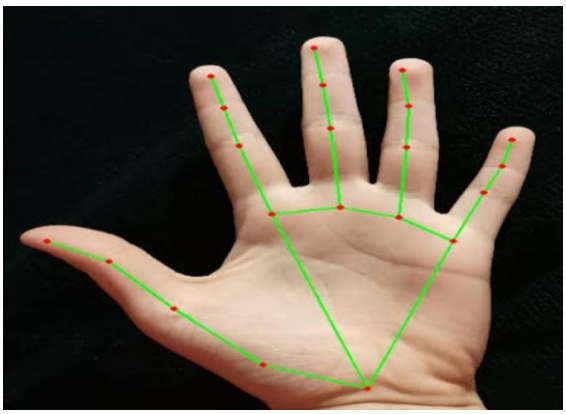

Fig. 5 Landmark Detection

B. Cursor Navigation

This utilizes OpenCV for image processing, NumPy for numerical computations, time for time tracking, and autopy for mouse control. It continuously captures video frames from the webcam, detects hands using the custom Hand Tracking module, and identifies finger positions. The index finger's movement controls the mouse cursor, while proximity between the index and middle fingers triggers a mouse's double click. It displays the frame rate and annotated image in real-time**.**

The algorithm is as follows:

1. Capture the image using the camera. Then extract and recognize the hand from the input image.
2. Determine which fingers are up if only index finger cursor movement is performed by mapping the coordinates of the index finger to the screen dimensions and smoothing the movement.
3. If both index and middle fingers are up and the distance between them is less than 40 then a double tap is performed.
4. Repeat the above steps until the execution has stopped.

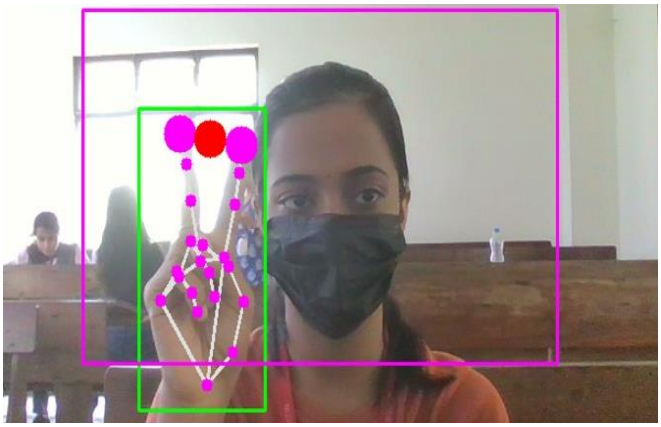

Fig. 6 Cursor movement with double click

C. PowerPoint Presentation Control

This utilizes a combination of OpenCV and the CV zone library for real-time hand tracking to enable control of a PowerPoint presentation through hand gestures captured via webcam. After initializing the connection with PowerPoint and setting up the webcam, the script continuously captures video frames and detects hands using the Hand Detector object. When a hand gesture is recognized, i.e., raising of thumb, the code triggers actions to navigate through slides accordingly. The algorithm is as follows:

1. Open the PowerPoint presentation and create a connection using win32com.client.
2. Capture the image using the camera. Then extract and recognize the hand from the input image
3. Determine which fingers are up

3.1 Check if the hand is at the height of the face

3.2 If true then check if the left-hand thumb is up which navigates to the next slide, or if the right-hand thumb finger is raised then navigates to the previous slide

4. If the slide navigates then wait for a short delay to avoid repeated slide changes.
5. Repeat the above steps until the execution has stopped

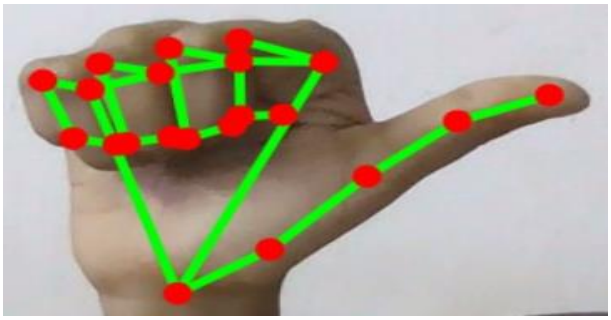

Fig. 7 Gesture for next slide navigation

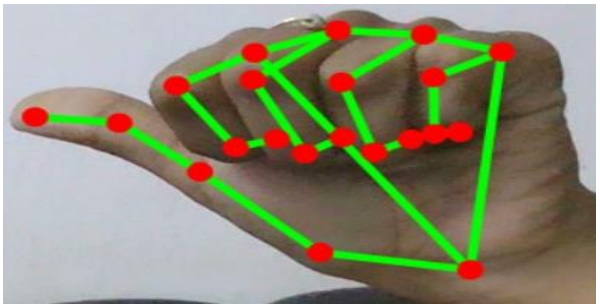

Fig. 8 Gesture for previous slide navigation

D. Virtual Keyboard

The virtual keyboard presented here offers users an intuitive way to interact with their devices through hand gestures captured by a webcam. Upon detecting a hand gesture where all left-hand fingers and the right-hand three fingers are raised, the virtual keyboard pops up on the screen, providing users with a set of keys for typing. The keys include letters, a spacebar (SP), a backspace (BP), a clear (CLR), CAP, and direction buttons. The CAP button is to select the lowercase or uppercase of the letters. The direction keys - UP, DN(down), LT(left), RT(right) are used to adjust the location of the keyboard. Adjusting its location ensures both keyboard access and a clear view of the content. Users can use their fingers to directly interact with the virtual keys to enter texts into any software. The algorithm is as follows:

1. Capture video feed from the webcam.
2. Detect hands in the video feed and track their landmarks.
3. Create and define the operations of the virtual keys for letters, space, backspace, and other functions.
4. Display the virtual keyboard on the screen.
5. When the user raises their index finger, it hovers over the letter keys displayed on the screen. Subsequently, a double tap using both the index and middle fingers selects the desired letter for typing.
6. Repeat the above steps until the execution has stopped.

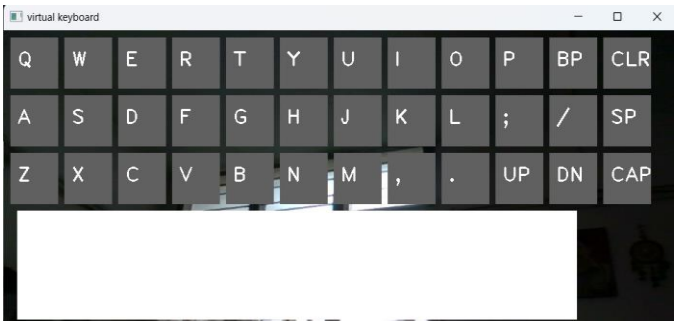

Fig. 9 Virtual Keyboard having Uppercase letters

Fig. 10 Virtual keyboard having lowercase letters

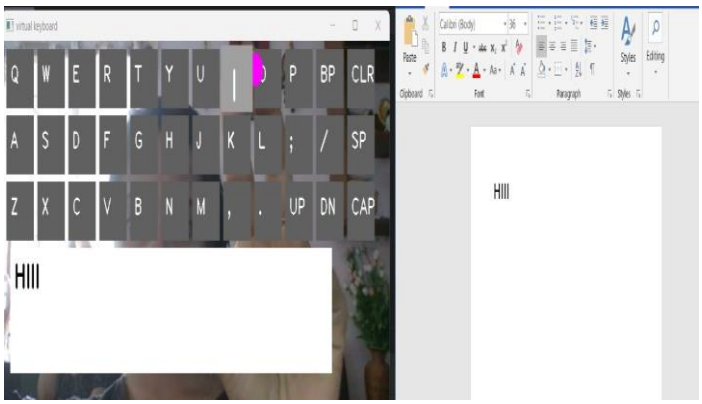

Fig. 11 Virtual Keyboard

E. Virtual Painter

The virtual painter application uses index finger gestures detected from a webcam feed. Upon detecting a hand gesture where the index, middle, ring, and pinkie right-hand fingers along with left-hand fingers are raised the virtual painter pops up on the screen. The user can control the brush color, brush size, and canvas visibility by just hovering over the button using an index finger. There is a clear option to clear the drawing and an eraser button to erase a particular portion that the user wants. To start drawing, the user just must draw in the air. Movements of the index finger will be tracked to draw strokes on the canvas, visible on the display in real-time.

The algorithm is as follows:

1. Capture the video feed from the webcam.
2. Detect hands in the video feed and track their landmarks using a hand-tracking algorithm.
3. define and display the canvas with a brush tool of different colors and an eraser, and display it on the screen.
4. When the user raises his index finger and hovers over the brush color, he can start drawing in the air, and the drawn strokes will be displayed on the canvas in real time.
5. When the user selects the eraser, the eraser gets selected, and part of the drawings, over which the index finger hovers, are erased.
6. When the user selects the clear button, the entire drawing is erased.

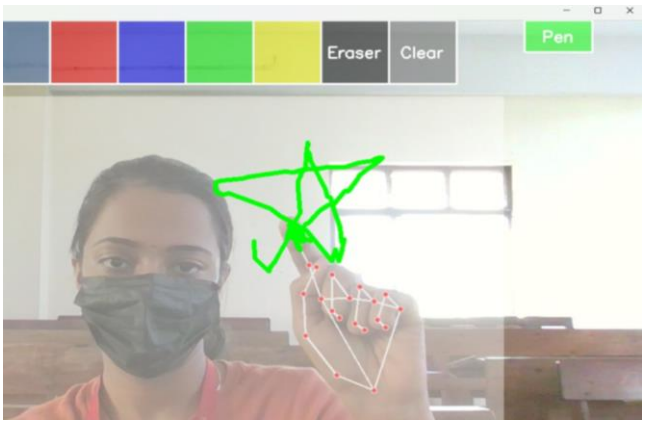

Fig. 12 Virtual Painter

IV. CONCLUSIONS

HandyPresenter is a groundbreaking innovation that redefines the art of presentations. By integrating mouse navigation with double-click functionality, a virtual keyboard, and a virtual painter – all controlled through intuitive hand gestures – HandyPresenter sets a new standard for interactive presentations. This all-in-one gesture control system liberates presenters from the constraints of traditional tools, enabling effortless navigation through slides, seamless typing on a virtual keyboard, and creative drawing directly on the screen.

Gone are the days of being tethered to a physical mouse or keyboard. HandyPresenter empowers presenters to deliver their content with unparalleled freedom and confidence. By embracing natural hand gestures, presenters can captivate audiences and foster genuine engagement. HandyPresenter isn't just a tool; it's a catalyst for dynamic and memorable presentations. It transforms the mundane into the extraordinary, enhancing every aspect of the presenter-audience interaction. With HandyPresenter, presentations become fluid expressions of creativity and professionalism. The intuitive controls facilitate a seamless flow of ideas, allowing presenters to focus on what truly matters – delivering impactful content that resonates with the audience. HandyPresenter opens doors to innovative storytelling, enabling presenters to adapt and respond in real time, creating immersive experiences that leave a lasting impression. In the realm of presentations, HandyPresenter is a game-changer. It encourages experimentation and exploration, pushing the boundaries of conventional presentation tools. The fusion of technology and human interaction elevates presentations to new heights of engagement and effectiveness. With HandyPresenter, the stage is set for transformative

experiences. It empowers presenters to showcase their expertise effortlessly, facilitating seamless transitions between ideas and interactions. HandyPresenter sparks curiosity and invites participation, turning passive viewers into active participants in the narrative. HandyPresenter is not just a tool; it's a gateway to a more impactful and memorable presentation experience. It empowers presenters to connect authentically with their audience, fostering a dynamic exchange of ideas and leaving a lasting impression long after the presentation ends.

REFERENCES

[1] Khanum, H., & Pramod, H. B. (2022). Smart presentation control by hand gestures using computer vision.International research journal of engineering and technology ,9(7), 482-487.

[2] Shriram S, nagaraj B, jaya J, shankar S, ajay P. "Deep learning-based real-time AI virtual mouse system to avoid COVID-19 spread." J healthc eng. 2021 oct 25;2021:8133076. Doi: 10.1155/2021/8133076. Retraction in: J healthc eng. 2023 oct 11;2023:9804176. Pmid: 34733459; pmcid: pmc8560261.

[3] S. J. Basha, L. S. L. Sowmya, S. Rumiya and S. Afroz, "Virtual Mouse with hand gestures using AI," 2023 4th International Conference on Electronics and Sustainable Communication Systems (ICESC), Coimbatore, India, 2023, pp. 1432-1438, doi: 10.1109/ICESC57686.2023.10193709.

[4] Waichal, Aabha & Gandhi, Mauli & Bhagwat, Srushti & Bhanji, Amruta & Deore, Shalaka & Ingale, Shubhangi. (2022). Hand Gesture Recognition based Virtual Mouse using CNN. International Journal of Computer Applications. 184. 19-23. 10.5120/ijca2022922217.

[5] R. Gupta and A. Singh, "Hand Gesture Recognition using OpenCV," 2023 10th International Conference on Computing for Sustainable Global Development (Indiacom), New Delhi, India, 2023, pp. 145-148.

[6] Y. Zhao, X. Ren, C. Lian, K. Han, L. Xin and W. J. Li, "Mouse on a Ring: A mouse action scheme based on IMU and multi-level decision algorithm," in IEEE Sensors Journal, vol. 21, no. 18, pp. 20512-20520, 15 Sept.15, 2021, Doi: 10.1109/jsen.2021.3096847.

[7] Y. Zhang, W. Yan and A. Narayanan, "A virtual keyboard implementation based on finger recognition," 2017 International Conference on Image and Vision Computing New Zealand (IVCNZ), Christchurch, New Zealand, 2017, pp. 1-6, doi: 10.1109/IVCNZ.2017.8402452.

[8] A. Enkhbat, T. K. Shih, T. Thaipisutikul, N. L. Hakim and W. Aditya, "HandKey: An Efficient Hand Typing Recognition using CNN for Virtual Keyboard," 2020 - 5th International Conference on Information Technology (InCIT), Chonburi, Thailand, 2020, pp. 315-319, doi: 10.1109/InCIT50588.2020.9310783.

[9] Ramadhan, Glenn & Wiratama, Jansen & Permana, Angga. (2022). Development of Virtual Painting Method using OpenCV Library with Finger Gesture on Online Learning Platform. JIKA (Jurnal Informatika). 6. 332. 10.31000/jika.v6i3.6875.

[10] S, Dr & R, Soundarya & S, Vaishnavi & S, Vanisri & S, Hiranya. (2022). AI Virtual Painter using OpenCV and Mediapipe. International Journal of Engineering Research in Computer Science and Engineering. 9. 13-16. 10.36647/IJERCSE/09.11.Art004.

[11] R. N. Phursule, G. Y. Kakade, A. Koul and S. Bhasin, "Virtual Mouse and Gesture Based Keyboard," 2023 7th International Conference On Computing, Communication, Control And Automation (ICCUBEA), Pune, India, 2023, pp. 1-4, doi: 10.1109/ICCUBEA58933.2023.10392123.