



## **Virtual Whiteboard-A Gesture Controlled Pen-free Tool**

***Kamlakant Bag<sup>1</sup>, Siddharth Urankar<sup>2</sup>, Ankita Yadav<sup>3</sup>, Resham Chaudhari<sup>4</sup>***

<sup>1,2,3</sup> Final Year Student, Computer Engineering Department, Viva Institute of Technology, India

<sup>4</sup> Assistant Professor, Computer Engineering Department, Viva Institute of Technology, India

---

### **ABSTRACT**

The computer vision field has been rapidly developing, finding real-world applications, and even surpassing humans in solving some of the visual tasks. All thanks to the recent advancement in artificial intelligence and machine learning. Object tracking is considered as one the important task within the field of computer vision. Virtual Whiteboard is a novel application that allows users to create digital drawings and presenting presentations using hand gestures. This innovative technology is designed to enhance the user experience and interaction, allowing users to create and control content without physically touching the screen or keyboard. The system uses a combination of computer vision and machine learning algorithms to detect hand movements and translate them into digital actions. The Virtual Whiteboard provides users with a variety of tools and features to create and manipulate digital content, including drawing and writing tools, as well as image and shape manipulation tools. It a versatile and powerful tool for communication and collaboration. The application is easy to use, and users can quickly learn to create and manipulate digital content with hand gestures. In addition to its creative and collaborative features, the Virtual Whiteboard also includes PowerPoint controlling capabilities. This feature allows users to control their PowerPoint presentations using hand gestures, making it a useful tool for public speakers and presenters. With this feature, users can advance or go back to slides, as well as draw or annotate over the slides in real-time. Overall, the Virtual Whiteboard is a powerful and versatile tool that enhances user experience and interaction, providing a new way to create and control digital content.

**Keywords:** Artificial Intelligence, Digital Drawings, Hand Gestures, Machine Learning, Object Tracking, Presentations, Virtual Whiteboard.

---

### **1. Introduction**

Virtual Whiteboard is a cutting-edge application that enables users to create digital drawings and presentations using hand gestures. This innovative technology provides a new way for users to interact with digital content, offering a more natural and intuitive user experience. The application uses advanced computer vision and machine learning algorithms to detect and interpret hand gestures, allowing users to create and manipulate content with ease. Virtual Whiteboard is designed to be a versatile and powerful tool for communication and collaboration. With a variety of tools and features, users can create and manipulate digital content to their liking. Drawing and writing tools, and PowerPoint controlling capabilities are all available in the application. The application's easy-to-use interface makes it accessible to users of all skill levels, allowing them to create and manipulate digital content with hand gestures quickly.

One of Virtual Whiteboard standout features is its PowerPoint controlling capabilities. Users can use hand gestures to control their PowerPoint presentations, eliminating the need for a clicker or keyboard. This feature makes it an ideal tool for public speakers, educators, and business professionals who want to engage their audiences in a more interactive and dynamic way. Users can advance or go back to slides, and even draw or annotate over the slides in real-time. A virtual whiteboard is a digital platform that mimics the features of a traditional whiteboard. It allows users to draw and write. A gesture-controlled virtual whiteboard eliminates the need for a stylus or a mouse and instead allows users to interact with the board using hand gestures.

---

### **2. Related Work**

Rafiqul Zaman Khan, et.al [1] provided a study on Hand Gesture Recognition, in this paper a survey of recent hand gesture recognition systems is presented. Key issues of the hand gesture recognition system are presented with challenges. Zhuihu hu, et.al [2] implemented Gesture detection using RGB hand image using convolutional neural network. In this paper we study the hand gesture recognition in human computer interaction. Pinar Kirci, et.al [3] have proposed Hand Gesture Detection, in this study, by using computer vision and image processing techniques, with interpreting the hand movements of the user that enter the vision field of the camera, it can be used more functionally and the user can manage the computer without any physical contact and as being away from the monitor. Ishika Dahl, et.al [4] demonstrated Automated Hand Gesture Recognition using a Deep convolutional neural network. This paper discusses and offers a state-of-the-art deep Multi-layer Convolutional Neural Network for performing hand gesture recognition in Human-Robot Interaction systems. Sumedh Bansode, et.al [5] have implemented Computer Vision Based Virtual Sketch Using Detection Developing an interface between human palm and the system using open cv techniques and python language to pick the tool and draw using hand on the developed drawing area. Yash Patil, et.al [6] proposed Virtual Painting with OpenCV Using Python This paint application is created using OpenCV module and python programming language which is an apex machine learning tool to create an application like this. Niharika M, et.al [7] have

proposed Virtual hand gesture recognition system. The virtual paint application's fundamental goal is to deliver an AI-based tool that allows users to draw anything on screen using hand movements. Ashfaq Ahmad, et.al [8] implemented Controlling PowerPoint Using Hand Gestures in Python The research has tried to control different operations of the PowerPoint slideshow through gestures. Pranavi Sugawara, et.al [9] demonstrated Virtual Sketch using Open CV, in this project we are performing the morphological operations are a set of operations that process images based on shapes. Zhenmin YUAN, et.al [10] implemented Sketch Recognition based Intelligent Whiteboard Teaching System, this paper realizes an intelligent whiteboard system based on sketch recognition.

---

### 3. Research Objective

Investigate the usability and user experience of a virtual whiteboard with gesture control as compared to traditional whiteboards or digital whiteboards with pen input. Evaluate the impact of a virtual whiteboard with gesture control on collaborative learning, knowledge retention, and engagement in educational settings. Analyze the potential benefits and limitations of using a virtual whiteboard with gesture control in various educational contexts, including remote and hybrid learning environments. Identify the key design and technical requirements for developing an effective and user-friendly virtual whiteboard with gesture control. Provide recommendations and guidelines for educators and developers on how to integrate and utilize virtual whiteboards with gesture control in teaching and learning. Investigate the impact of hand gesture control on user engagement, interaction, and overall presentation experience. Analyze the potential benefits and limitations of using hand gesture control for PowerPoint presentations in various settings, including academic, professional, and entertainment contexts. Evaluate the user experience and satisfaction of using hand gesture control for PowerPoint presentations in comparison to traditional methods, such as using a keyboard or mouse.

---

### 4. Proposed System & Methodology

#### 4.1.1 Methodology

The objective is to create a free space where one can draw in air freely. The RGB camera detects the fingertip and tracks its motion throughout the screen. Whenever the hand comes in front of the camera, the initial thing to do is detect the fingertip. There are various ways of fingertip detection.

#### 4.1.2 Fingertip Detection:

The objective of the proposed system is to create a precise fingertip detection system. The system will initially detect the entire hand, followed by region segmentation consisting of two steps: skin segmentation and background subtraction.

#### 4.1.3 Fingertip Tracking:

Once the hand region and center of gravity have been successfully detected, the subsequent step is to track the movement of the fingertips on the screen. Previous research has shown that using the faster R-CNN handheld detector is computationally intensive, resulting in a lower frame rate that is below real-time performance. Therefore, the aim of this study is to use the KCF tracking algorithm instead. This algorithm first converts the detected fingertip into the HSV color space. Once the fingertip mask is identified in the air, the system performs various morphological operations to remove impurities from the masked image. The next critical step involves detecting the contours and drawing the line. To accomplish this, a python deque is created that memorizes the outline's position in each subsequent frame. The deque accumulates these points and uses them to create a line using OpenCV's drawing capabilities. This approach allows for precise and efficient fingertip tracking, even in real-time scenarios.

#### 4.1.4 The methodologies or the stages of the proposed system are discussed below:

##### 1. Run or Execute the Code

Execute the code once all the libraries are installed, this leads to turning the camera on automatically and the OpenCV frame with buttons displaying different colors, erase, clear, size etc.

##### 2. Webcam Starts

The webcam begins recording and then converts each video frame before sending it to the hand tracker class. The hand tracker class is responsible for detecting and tracking the positions of the fingers in each frame.

##### 3. Detects Hand Landmarks

Each frame received is compared with mediapipe hand landmarks.

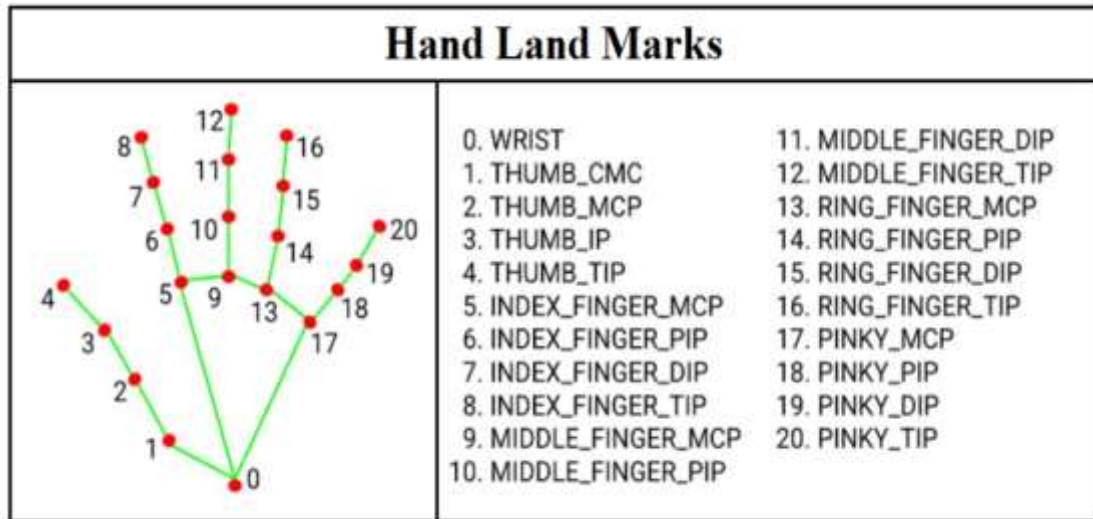


Figure 1 Landmark Detection Table

Figure 1 shows the 21 hand points that are identified by MediaPipe for hand gesture recognition. The hand landmarks are numbered from 0 to 20, which are the key points that MediaPipe uses to identify the hand pose. These key points are fed into a pre-trained gesture recognition network to recognize the hand gesture. MediaPipe uses a single-shot palm detection model to detect the hand region and then performs precise key point localization of 21 3D palm coordinates in that detected region. The MediaPipe pipeline utilizes multiple models, including a palm detection model that returns an oriented hand bounding box from the full image. The cropped image region is then fed to a hand landmark model defined by the palm detector, which returns high-fidelity 3D hand key points.

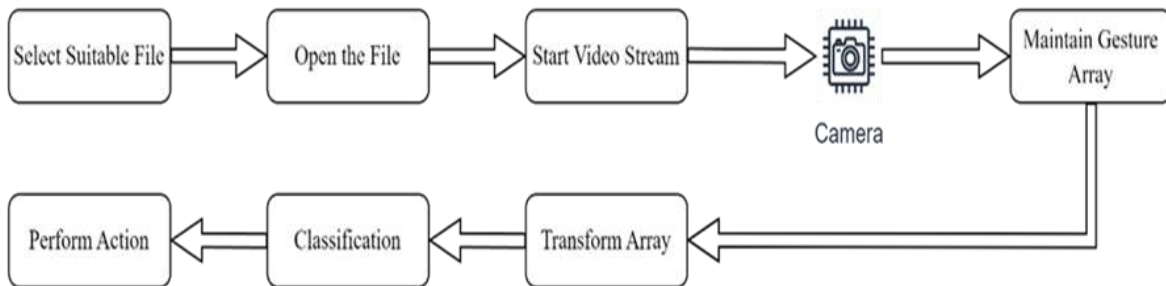


Figure 2 Step Diagram

Figure 2 The first and second phases of the system involve selecting and opening a PowerPoint file, which will be presented on the PowerPoint window. In the third phase, the system initiates a live video stream to detect and recognize live gestures. In the fourth phase, the gesturing is recorded as an image array of size 20. The fifth phase involves transforming this array, while in the sixth phase, the system classifies the array of images using pre-trained weights that were previously loaded. This approach enables accurate recognition and classification of live gestures, which can be used to control various features in the PowerPoint presentation.

#### 4.1.7 Use Case Diagram

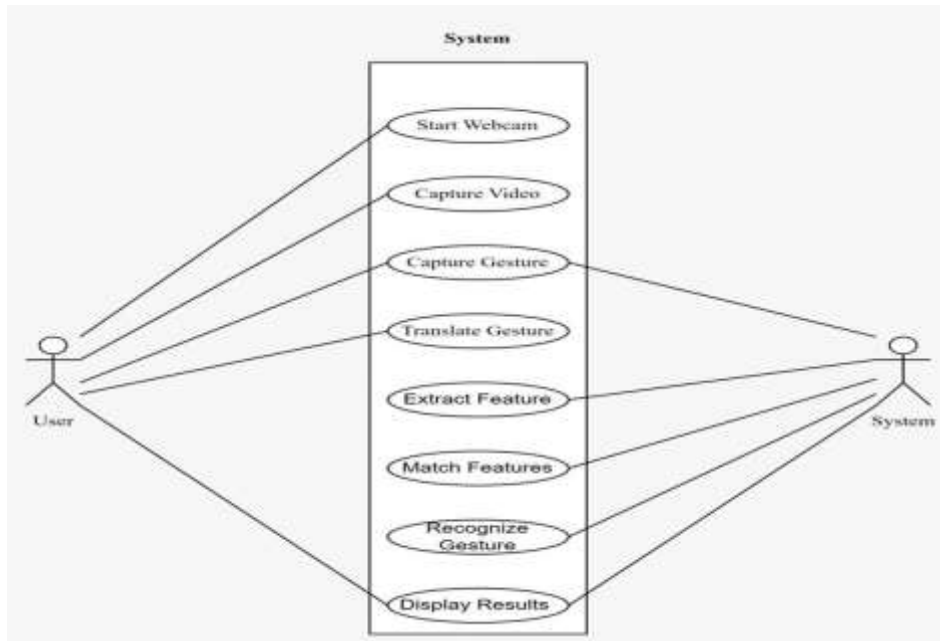


Figure 3 Use Case Diagram

Figure 3 Use case diagram represents the interaction between a user and a system, is a use case diagram representing the interaction between a user and a system, which shows the relationship between the user and the various use cases involved. The diagram begins by starting up the webcam and taking inputs using hand detections. These inputs are then given appropriate frame rates, and actions are performed based on the detected gestures. This diagram provides a clear visual representation of how users interact with the system and the various use cases involved, which helps in understanding the functionality of the system from the user's perspective.

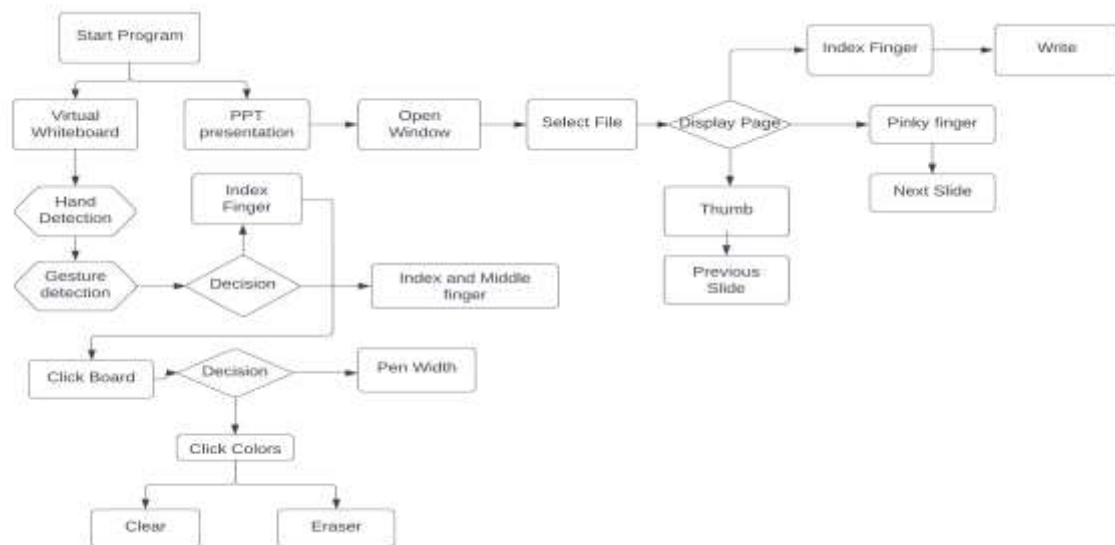


Figure 4 Activity Diagram

Figure 4 Displays an activity diagram depicting the overall system of the virtual whiteboard and PPT controlling software. The diagram illustrates the various actions and decision points involved in using the software, including opening the virtual whiteboard and performing activities such as drawing and erasing drawings, selecting a presentation file, navigating slides, and drawing on slides for effective explanation without using any hardware devices. Additionally, the diagram shows how the user interacts with the software and any conditions or loops that may occur during the process. Overall, the activity diagram provides a visual representation of the steps involved in controlling PPT using the virtual whiteboard, offering a clear understanding of the software's functionality and user interaction.

## 5. Results & Analysis



Figure 5 Preparing Home Screen

Figure 5 Displays the first window of the program greets the user with a clear and concise interface. It includes two labels and two buttons. The first label describes the virtual whiteboard functionality of the program, which allows users to draw and write using their hands without any additional hardware. The second label describes the PowerPoint control feature, which enables users to control their presentation using hand gestures. The first button is placed beneath the virtual whiteboard description and serves as the start button for this feature. The second button, located below the PowerPoint control description, is used to initiate the presentation mode. The interface is designed to provide users with an easy and intuitive way to access the program's features.



Figure 6 Performing Paint

Figure 6 The figure illustrates the functionality of the program where the user clicks on "Let's Draw" button to activate the camera to detect their hands and display them on the virtual whiteboard. The system uses 21 landmark points to predict the user's hand gestures and perform the corresponding actions, which are predefined and mapped to specific functionalities such as selecting a tool or drawing on the virtual whiteboard. The user can choose from a variety of colors, clear the screen, use an eraser tool to erase specific portions, and modify the width of the pen or eraser by moving the hand towards the pen button and making the necessary adjustments. The system uses image processing and pattern recognition techniques to accurately detect the user's hand movements and translate them into meaningful actions on the virtual whiteboard, providing an intuitive and versatile drawing experience for users of all skill levels.

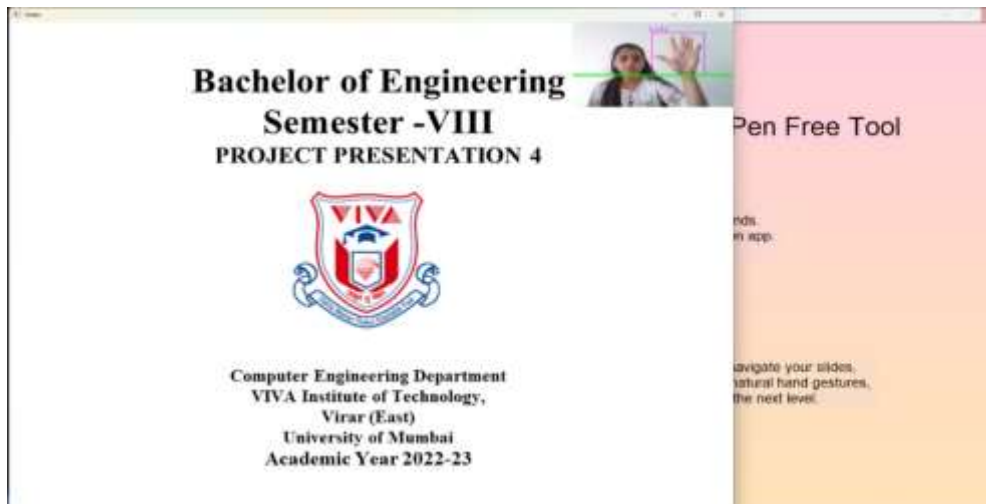


Figure 7 Preparing Presentations

Figure 7 Shows the first slide of the presentation that displays a video window on the top right corner, which captures the user's actions through hand gestures. The video feed shows the user's hand landmark detection, which is used to interpret the user's actions. A green line is drawn horizontally on the video screen, which serves as a threshold for the user to move to the next or previous slide. To perform the action, the user needs to move their hand above the green threshold line. This allows for a more intuitive and natural way of controlling the presentation without the need for additional hardware or devices.

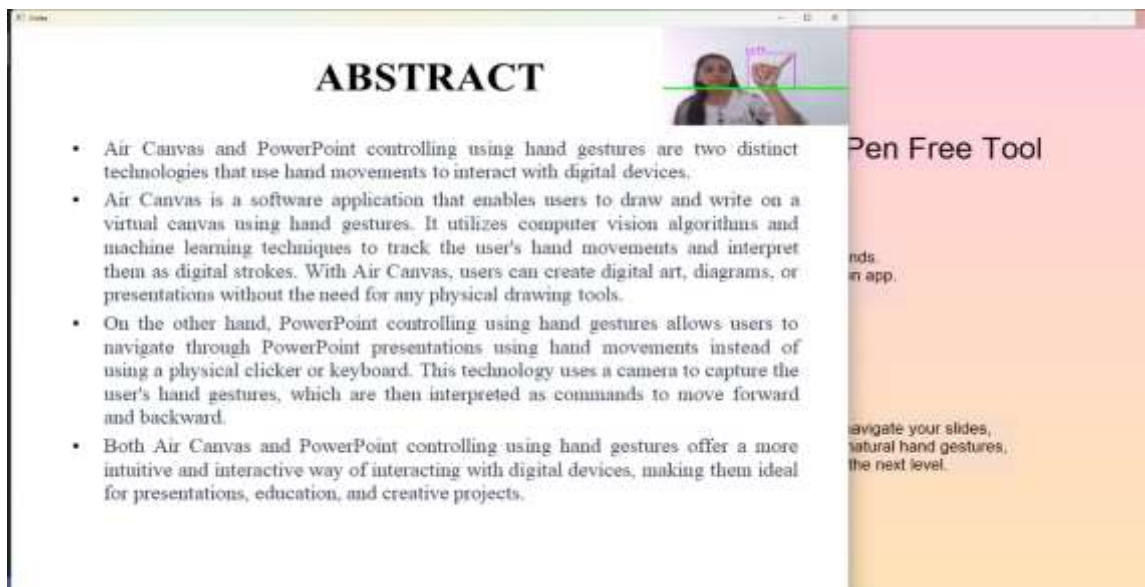


Figure 8 Gesture Control for Slides Navigation

Figure 8 The depicts a user performing hand gestures to navigate through a presentation. The green threshold line on the video screen serves as a marker for the user's actions. In one instance, the user moves their right hand to the right with the pinky finger extended to move to the next slide. In another instance, the user moves their thumb to the left to move to the previous slide, while their hand is positioned above the green threshold line. The program utilizes image processing techniques to detect the user's hand landmarks and interpret their actions, providing an intuitive and interactive presentation experience.

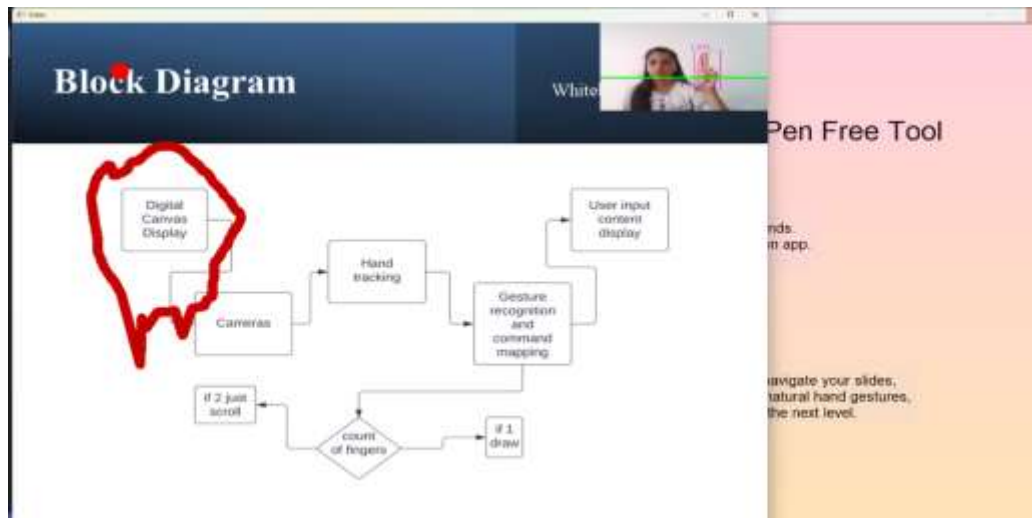


Figure 9 Hand Gesture Control for Drawing and Pointing on Presentation Slides

Figure 9 Displays the user drawing on the slide using their index finger which is raised. The user's actions are detected by the camera and the movements are reflected on the screen. If the user raises their middle finger along with the index finger, a pointer appears on the screen. The pointer can be moved by the user's hand to point to a specific location on the slide. This functionality eliminates the need for a mouse or a laser pointer to point to specific locations on the slide.

## 6. Conclusion

The use of virtual whiteboards and hand gesture control for PowerPoint presentations has the potential to revolutionize the way we teach, learn, and present information. These technologies offer a more interactive and engaging platform for collaborative learning and presenting ideas. The virtual whiteboard with gesture control eliminates the need for a stylus or a mouse, making it more accessible and user-friendly. Similarly, hand gesture control for PowerPoint presentations provides a more natural and intuitive way of controlling the content. These technologies have the potential to improve user engagement, interaction, and overall experience, making teaching and learning more effective and enjoyable. However, there is a need for further research and development to optimize these technologies and identify their full potential. Overall, the use of virtual whiteboards and hand gesture control for PowerPoint presentations represents an exciting new frontier in education and communication technology.

## References

1. Rafiqul Zaman Khan, Noor Adnan Ibrahim "Hand gesture recognition" IJAIA 2020
2. Z. Hu, X.Zhu "Gesture detection from RGB hand image using modified convolutional neural network." IEEE 2019
3. P.Kirchi, M.Cambek "Hand Gesture detection" IEEE 2019
4. I.Dhall, S.Vashisth, G.Aggarwal "Automated Hand Gesture Recognition using a Deep Convolutional Neural Network model." IEEE 2020
5. S.Bansode, S.Varkhad, S.Dhaigude, S.Waghmare, S.Suryawanshi "Computer Vision Based Virtual Sketch Using Detection." IJRASET 2022
6. Y.Patil, M.Paun, D.Paun, K.Singh, V.Borate "Virtual Painting with Opencv Using Python." IJSRST 2020
7. Niharika M, Neha J, Mamatha Rao, Vidyashree K P "Virtual paint using hand gesture" IRJET 2022
8. M.Idrees, M.Butt, A.Ahmad, H.Danish "Controlling PowerPoint using hand gesture in Python" ResearchGate 2021
9. P.Srungavarapu, P.maganti, S.Sakhamura, "Virtual Sketch using Open CV" IJITEE 2020
10. Z.Yuan, G.Jil, "Sketch recognition based intelligent whiteboard teaching system" ICCSSE 2008
- 11.