GESTURE MASTER: REAL-TIME GESTURE CONTROL FOR INTERACTIVE PRESENTATION USING COMPUTER VISION

A PROJECT REPORT

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In partial fulfilment for the award of the degree of

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Under the esteemed guidance of

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BONAFIDE CERTIFICATE

This is to certify that the project work entitled "**GESTURE MASTER: REAL-TIME GESTURE CONTROL FOR INTERACTIVE PRESENTATION USING COMPUTER VISION**" is a bonafide work done by **A. PAVAN KUMAR (32113291002) , T.DILEEP (32113291054), K. KARTHIK (32113291025), D. PRAKASH(32113291062)** as a part of IV/IV B.Tech 2nd Semester of Computer Science and Engineering during the year 2021-25.

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External Examine

DECLARATION

We hereby declare that the work entitled **"GESTURE MASTER: REAL-TIME GESTURE CONTROL FOR INTERACTIVE PRESENTATION USING COMPUTER VISION"** is our original work, carried out under the guidance of **G. VIJAYA LAKSHMI,** Assistant Professor, and submitted to the Department of Computer Science and Engineering**, SANKETIKA VIDYA PARISHAD ENGINEERING COLLEGE**, for the partial fulfillment of the requirement for the award of Bachelor of Technology in Computer Science and Engineering.

We also declare that this project is a result of our own effort and that it has not been submitted to any other university for the award of any Degree.

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ABSTRACT

This project presents a Hand Gesture-Based Presentation Control System that uses computer vision and speech recognition to enable users to control PowerPoint presentations using hand gestures and voice commands. The system utilizes the cvzone library and OpenCV to recognize hand gestures, enabling users to move slides forward and backward, manipulate a virtual pointer, create annotations with a specific color, delete content, and even zoom in or out with simple hand gestures.

Furthermore, an enhanced speech recognition module based on the Speech Recognition and PyAudio libraries allows users to jump directly to a particular slide using voice commands. The system to be proposed increases presentation delivery accessibility and efficiency, as it eradicates the use of conventional input devices such as keyboards, mouse, or clickers.

The system works with a webcam to record hand gestures in real-time, and this provides smooth and interactive presentation delivery. A threshold-based method is employed to differentiate gesture inputs, with the aim of providing accuracy. Different light conditions and usage patterns are tested for the system to ensure its reliability and ruggedness.

The outcome shows the efficacy of presentation control through hand gesture recognition opening up future possibilities such as the incorporation of machine learning-based gesture classification and personalized gesture mapping. This study adds to the emerging field of Human-Computer Interaction (HCI) and seeks to redefine the conduct of presentations with a more natural and interactive approach.

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CHAPTER – 1

INTRODUCTION

INTRODUCTION

1.1 INTRODUCTION TO GESTURE RECOGNITION

Gesture recognition is an advanced form of human-computer interaction (HCI) that enables machines to understand human hand movements as input commands. Gesture recognition systems employ computer vision and machine-learning techniques to perceive, track, and analyse gestures in real-time and respond instantaneously to any interaction involving a digital system.

The idea behind gesture recognition is essentially to provide an easy and natural way for users to interact with a device without relying on any traditional forms of inputs, be it a keyboard, mouse, or touchscreen, for its execution. The application of gesture recognition technology is seen in virtual reality (VR), gaming, controlling robotics, sign interpretation, and touch-free control interfaces.

Gesture recognition systems can be broadly classified into two categories based on their mode of operation:

1. **Vision-based systems**- These systems usually use computer vision algorithms to monitor and process the hand movements from cameras. They use techniques such as edge detection, contour mapping, and deep learning models for gesture recognition. Vision-based systems have the advantage of not requiring physical touching or wearing any gadget.[8]
2. **Sensor-based systems**- This group of systems collects motion data through hardware sensors, such as accelerometers, gyroscopes, or infrared sensors. Although more accurate and better tracking motions, they are hindered by hardware costs and thus compromise the competitiveness of these solutions against vision-based ones.[8]

Modern gesture recognition relies heavily on deep learning algorithms, in particular convolutional neural networks (CNNs), allowing very advanced gesture detection, with excellent accuracy and adaptability to detection of gestures. Gesture control systems have come to recognize highly sophisticated hand

movement commands with great precision, with the help of artificial intelligence coupled with real-time image processing.[9]

This project application of gesture recognition systems allows a touch-free interface for controlling interactive slides in presentations. Using OpenCV and cvzone, the system detects gestures with high precision, defining commands for switching slides, annotation, and cursor actions, based on hand movements. Gesture-based interaction has been implemented to make presentations more attractive and user interactive. Supports claims about deep learning-based gesture recognition and real-time processing.[13]

Also, together with gesture recognition, speech recognition was additionally used, as the user could speak a command to jump to a particular slide, thus adding on to the overall usability of the system. This vision-based gesture recognition, together with speech input, gives more flexibility and is a fairly good alternative for any conventional presentation controls.

1.2 PROBLEM STATEMENT

Traditional methods of controlling PowerPoint presentations rely on physical input devices such as keyboards, mice, or remote clickers, which can be inconvenient in scenarios such as live presentations, classrooms, or interactive sessions. These methods require constant physical interaction, limiting mobility and disrupting the flow of the presentation.

To enhance the user experience and provide a seamless, hands-free alternative, this project aims to develop a **Hand Gesture and Voice-Controlled Presentation System** using **computer vision and speech recognition**. The system enables users to navigate slides, draw annotations, erase content, and interact with presentations effortlessly using hand gestures and voice commands.

By leveraging OpenCV, cvzone, pyautogui, and speech recognition libraries, the proposed system eliminates the dependency on traditional input devices and introduces an intuitive and efficient way of engaging with presentation content.

This approach improves accessibility, enhances user experience, and provides an innovative solution for hands-free presentation control.

1.3 BACKGROUND OF THE PROJECT

Today, technology is adapted to making things more interesting and intuitive. From simple swipe gestures on mobile phones to sophisticated voice commands for smart speakers, the trend is followed in communicating with devices in ways that are more natural. One aspect that seems not to have changed much over the years is that in the year 2025, most presenters continue to use remote clickers, keyboards, or touchpads to control slides, which impairs their mobility and interaction. [10]

A real-time-life situation where a major group presentation was marred served as an inspiration to the idea in this project. The remote clicker stopped working, and the students were left struggling to navigate the manual way, thus interrupting with the proceedings of the event. This served as a motivation for such an event to search into a better alternative which is more effective and touch-free. Taking advantage of computer vision, it investigates hand-gesture recognition and presents a whole new way in which presentations are done.

Ultimately, this framework comprises OpenCV and cvzone, thus real-time hand tracking and gesture recognition without any physical input devices. Moreover, it adds speech recognition so that the user can now proceed to a certain slide with a voice command, which increases the accessibility and simply user-friendliness of the system.

Most Important Features in the system include:

- Slide Navigation: Simple hand movements to navigate slides forward and backward.
- Cursor Control: Control on-screen cursor movement other than a mouse.
- Drawing & Annotation: Draw on slides to mark some important points.
- Content Eraser: Erases content with a special gesture.
- Voice-Activated Slide Selection: Go to any slide using speech recognition.

As opposed to traditional solutions requiring the use of specially dedicated hardware, like motion controllers or wearable sensors, the current system can work using a simple webcam render-ing it cost-efficient and, therefore, widely accessible. Also, it tackles part of the serious problems that seriously affect gesture-based systems, such as uneven lighting and spontaneous gestures, using strong detection mechanisms.

With that touch-free presentation control system driven by Artificial Intelligence, this project aims to be of benefit to teachers, professionals, and students in their interaction with slides, bridging the gap between the present and the future with the mainstream lines of interactive presentations.

1.4 RESEARCH AND TECHNOLOGICAL GAPS

Research on modern gesture technology has a great many challenges to meet at present, as one would expect from a technology striving to be optimal and as usable as possible in real-world applications on several fronts including:

Limited Accuracy in Complex Environments:[1]

- Gesture recognition system performance is severely compromised in dynamic environments with changing lighting and anthropogenic noise, thus making it less accurate.
- In a multi-user high-movement environment, compromised performance may lead to a wrong gesture interpretation or false positives.

Occlusion and Hand Recognition Errors:[8]

- Some causes, such as partial obstruction of the monitored hand by the camera, make tracking a hand-delivered gesture impossible.
- Some hand orientation is difficult to recognize and thereby impedes the reliability of interaction in real time.

Standardization Absence in Gesture-Based Interfaces:[9]

- Different systems use different gestures to perform the same functions; hence, platform-to-platform, the inconsistencies.

• A lot of activity done in one universe should conform to a standard so widely accepted that usability and flexibility could become enhanced.

Adaptive thresholding methods [14] can mitigate lighting variations.

Computation Intensity and Real-Time Performance:

Real-time display of gesture detection and tracking does require quite intensive computation making it currently impossible to use these features on low-end devices.

Real-time applications could have slightly delayed interaction meaning the user could get very annoyed by it.

1.5 PROJECT OBJECTIVES

This project aims to develop a system for gesture-controlled presentations, which is meant to give convenience and intuitiveness to the users in interaction without requiring any physical input device. The system should, therefore, guarantee a hands-free experience that does not require any interruptions and relies on computer vision and speech recognition technologies. Strengthens the rationale for combining voice and gesture controls.[15]

1. Create an Intuitive and Contactless Presentation Control System.

- Develop a real-time hand-gesture recognition system using OpenCV and cvzone.
- Movement by hand replaces all other conventional inputs, including remote clickers and keyboards.

2.Increase accessibility and inclusivity:

- Mobility disabilities are facilitated with alternative provision for controlling presentations.
- Include accessibility through speech recognition for voice-control slide navigation.
- Create Presentation Activity and Visibility Enhancements

3. Include Voice Commands for Sliding Navigation:

- The SpeechRecognition library here is sure to enable the user sliding transition by voice command.[12]
- Modification of interaction defines also including voice and gesture recognition.

4. Provide Real-time Processing and Excellent Accuracy:

- Optimize the gesture recognition algorithms for real-time processing with acceptable latency as minimum as possible.
- Better accuracy and responsiveness on various lighting conditions and backgrounds.

5. Suggest a Hardware-efficient and Cost-effective System:

- Utilize a common webcam for gesture recognition as an alternative rather than implementing another hardware.
- The system should be capable of performing on consumer-level computers, and there are no high computations required.

6.Make cross-platform capabilities:

- Development of systems that operate on various platforms like Windows, Linux, and Mac OS.
- Facilitate development for some of its most beloved presentation applications, like Microsoft PowerPoint and Google Slides.

7. Secure and Minimize False Gestures:

- Mediating unintended input through gesture filtering technique.
- Process only meant gestures to avoid misunderstanding.

1.6 ORGANIZATION OF THE DOCUMENT

The document is divided into five chapters, which encompass the entire working of the Hand Gesture Controlled Presentation System using Computer Vision.

Chapter 1 - Introduction: It deliberates on gesture recognition in general, its importance in Human-Computer Interaction (HCI), and the motivation behind the project. In addition, it states the problem statement and objectives.

Chapter 2 - Literature Survey: This chapter discusses prior research efforts and related works on those fields of gesture-based systems by analyzing different techniques and methodologies followed by the earlier researchers.

Chapter 3 - System Development: In this chapter, the system architecture, the different modules involved, and the different technologies involved are explained. These technologies include OpenCV, cvzone, and speech recognition. Following this, the chapter elaborates upon the system's workflow, algorithms, and techniques employed.

Chapter 4 - Performance Analysis: This chapter tests the efficiency of the system - the accuracy, response time, and computational efficiency. Different testing methodologies and outcomes will be further discussed.

Chapter 5 - Conclusions and Futures: The final chapter summarizes the findings of the study, highlights the key contributions, and makes recommendations for potential improvements and possible applications of the system in the future.

CHAPTER – 2

LITERATURE SURVEY

LITERATURE SURVEY

2.1 LITERATURE SURVEY

1. Interactive way of Presentation control by Hand gesture[1]

Authors: A. Bhanupraaksh, V. Umesh, B Indupriya, R. Vijayalakshmi

Publication details: IJNRD (International Journal of Novel Research and Development), ix:5: May 2024, ISSN 2456-4184

Algorithm Used: OpenCV for hand tracking; feature extraction; thresholding methods.

Summary: Touchless presentation control using hand gestures is described in this paper. Hand gestures are the sole ways through which these presentations can be controlled; thus, no external keyboards or remote clickers exist. This method allows for gesture control with the capability to work in conjunction with OpenCV for real-time hand tracking and gesture recognition. The effect of different experiments on gesture recognition accuracy in different light conditions and in the case of differently sized hands are discussed. Different methods of feature extraction for contributing towards consistency and false positive elimination are discussed by the authors. They also pointed out areas of enhancement, such as employing deep learning algorithms, i.e. CNNs, for better recognition. A future improvement area would be adaptive thresholding methods for better measurement under changing environmental conditions.

2. Hand Gesture-Based Smart Presentation System [2]

Authors: Bhairavi Pustode, Vedant Pawar, Varun Pawar, and Others

Publication Details: Research Square [Preprint] in the year 2023.

Algorithm Used: OpenCV, image processing using Python, Haar cascade classifiers.

Summary: The research proposed here discusses the hand gesture presentation system that allows user interaction in academic and professional settings. The system captures hands using OpenCV and Python and converts the tracking

results into commands for navigating through slides. The paper evaluates the accuracy of recognition against different positions of hands and proposes a mechanism of feature selection for reducing misclassification. The paper explains gesture-operated interfaces further to the benefit of mobility-impaired users. The paper points out major restrictions, in this case, the speed at which hand gestures are performed, and recommends that AI-powered gesture prediction models must be utilized to facilitate smooth interaction.

3. Study of Hand Gesture Controlled using OpenCV and Python[3]

Authors: Chetana D. Patil, Amrita Sonare, Aliasgar Husain, Aniket Jha, Ajay Phirke

Year of Publication: 2022

Publication details: IJCRT (International Journal of Creative Research Thoughts), Volume 10, Issue 11, November 2022

Algorithms Used: Contour detection, deep learning models, feature extraction

Summary: It is a review that has hand gesture recognition in complete detail using OpenCV and Python. The various algorithms that could possibly exist are explained, including shape-based tracking, feature extraction, and deep learning-based classifiers. For contour detection and CNN-based approaches, the efficacious method is evaluated on the basis of the computational complexity and real-time performance. Gesture overlapping, skin tone variation, and lighting interference are a few of the challenges that the paper covers. The authors, however, advocate hybrid remedies as those using CNN with feature extraction technologies to improve the recognition accuracy and sensitivity.

4) Hand Gesture Presentation Using Machine Learning[4]

Auhtors: Devivara Prasad G, Mr. Srinivasulu M

Year of Publication: 2022

Publication details: IJIRT (International Journal of Innovative Research in Technology), Volume 9, Issue 4, September 2022

Algorithms Used: Machine learning classifiers, CNN, Support Vector Machines (SVM)

Summary: A machine learning-based method would automate the system using hand gestures for presentation. Deep learning networks, such as CNNs and SVMs, are employed in the paper for gesture classification, and precise classifications of pre-defined gestures by way of high accuracy have been included. The authors compare the performances of different classifiers with the state-of-art machine learning algorithms and bring the conclusions across the trade-offs concerned with how quickly the speed with which processing and recognition is achieved. They look into how crucial the quality of the dataset is in training the model and propose a data augmentation strategy for robustness. They proposed reinforcement learning as hybrid models for automatically adjusting gesture recognition over time with experience.

5. CNN-Based Indian Sign Language Vision Hand Gesture Recognition[5]

Authors: Jayesh Gangrade and Jyoti Bharti

Year of Publication: 2021

Publication details: International Journal of Computer Engineering Research Trends

Algorithms Used: Edge Detection and Convolutional Neural Networks (CNN)

Summary: The vision system developed for ISL recognition through deep learning. The model uses a convolutional neural network capable of good hand pose classifications ignoring occlusions and variation in gestures. The paper also gives comparative study for different architectures of CNN regarding performance for the sign language translation. The authors outline the preprocessing phases (hand segmentation, background removal) that increase model accuracy. The paper includes actual application case functions.

6. Human-Computer Interaction Based on Speech Recognition[6]

Authors: Ruixin Lu, Renjie Wei, Jian Zhang

Year of Publication: 2024

Publication details: Applied and Computational Engineering, Volume 36

Algorithms Used: Hidden Markov Models (HMM), Recurrent Neural Networks (RNN)

Summary: The article discusses speech recognition as a sub-area in HCI. The article outlines the various algorithms including Hidden Markov Models and Recurrent Neural Networks that can provide speech-to-text conversion. The article considers the applicability of voice-activated presentation systems as well as accessibility through different abilities. In the conclusion, the proposals of noise-reduction strategies will increase accuracy. The authors investigated HMM plus attention-based RNN for listening and understanding scenarios with multiple speakers. Other challenges articulated in the review are computational cost and response time.

7. New Evocations in Tactile Hand Gesture Recognition Towards Enhanced HCI [7]

Authors: Chiara Fumelli, Anirvan Dutta, Mohsen Kaboli

Year of Publication: 2024

Publication details: arXiv preprint arXiv:2405.17038

Algorithms Used: Deep learning models, tactile sensing-based gesture recognition

Summary: This paper contains about the HCI and how it is integrating in todays technology. Using an enormous area tactile sensing interface built of conductive fabrics, this work presents a very successful tactile hand gesture recognition platform. Traditional engineered features and deep learning methods in real time to give gestures can enable the exploration of different gestures based on hand type, speed of motion, pressure, and location of touch. The other noteable point is that this system also derives much more accurate solutions to the vision-based methods currently.

8.Real-Time Hand Gesture Recognition: A Comprehensive Review of Techniques, Applications, and Challenges[8]

Authors: Aws Saood Mohamed et al.

Year of Publication: 2024

Published in: Sciendo – Cybernetics and Information Technologies

Algorithms Used: Traditional handcrafted features, deep learning-based gesture recognition.

Summary: This extensive review summarizes progress, challenges, and future directions in hand gesture recognition (HGR) in real time. It addresses various technologies involved in HGR, including sensors, vision technologies, and AI-generated recognition models. The article discusses a variety of recognition approaches and compares traditional handcrafted feature extraction approaches with deep learning such as CNNs and RNNs. It emphasizes challenges associated with HGR such as gesture misclassification, computational intensity, and system latency and presents AI-based models that can be incorporated to enhance gesture classification accuracy.

9.Deep Learning-Based Hand Gesture Recognition System and Design of a Human–Machine Interface[9]

Authors: Abir Sen, Tapas Kumar Mishra, Ratnakar Dash

Year of Publication: 2023

Publication details: Neural Computing and Applications, Springer

Algorithms Used: Convolutional Neural Networks (CNN), Vision Transformers (ViTs)

Summary: This study describes an HGR system based on deep learning, as well as the design of a human–machine interface. The system uses Convolutional Neural Networks (CNNs) and Vision Transformers (ViTs) to identify hand gestures in real time. It explores several datasets and deep learning architectures to find one that achieves good recognition accuracy. The authors also discuss potential uses for the system in virtual reality (VR) and gaming, robotics, and health care. The authors also propose a framework for real-time implementation

in a method that could be integrated into commercial applications for touchless interaction.

10.Dynamic Hand Gesture Recognition Based on Short-Term Sampling Neural Networks[10]

Authors: Wenjin Zhang, Jiacun Wang, Fangping Lan

Year of Publication: 2021

Publication details: IEEE/CAA Journal of Automatica Sinica

Algorithms Used: Short-term sampling neural networks, real-time temporal feature extraction

Summary: This paper proposes a dynamic hand gesture recognition framework that uses short time sampling neural networks to effectively fetch temporal characteristics from gesture streams. This framework enables better recognition and robustness to variations in the environment; the authors have presented a comparison among various gesture recognition neural network architectures and applications in a human-computer interface with good improvement in real-time gesture applications. The authors explore trade-offs between complexity and real-time performance in their system whilst also introducing a gesture-based interactive experience with an optimized methodology.

2.2 EXISTING SYSTEM:

The existing system control mechanisms of PowerPoint presentations are predominantly based on conventional input devices like remote clickers, keyboard, mouse, and touchscreens. These mechanisms need physical contact, thus limiting the mobility of users and causing disruption in presentations. Moreover, despite the advent of advanced technology leading to the emergence of gesture-based presentation control systems, most such solutions lack strength in hardware specifications, precision, and flexibility.

One such available system in this domain is KALI, which is a computer vision and machine learning algorithm-based gesture-controlled PowerPoint controlling application that enables controlling of slides. With KALI, the user can proceed to

the next slide, zoom in/out, highlight on slides, and clear content as per pre-defined hand gestures. The system receives input from a webcam through OpenCV and senses hand movement based on image processing. Based on the orientation and finger position, it specifies the corresponding actions, like moving forward or backward in a slide show.

Though KALI is a revolution in Human-Computer Interaction (HCI), there are some limitations that prevent it from being used universally. The greatest limitation is the accuracy of the gesture recognition based on lighting, background texture, and hand occlusion. If one of the parts of the hand is out of the camera's view or if the light is not optimal, the system will not be able to identify the gestures correctly and can generate wrong actions or even no action.

A further significant limitation is that KALI has no facility to provide any support for input beyond hand gestures, so voice commands are not supported. This will limit access, especially for users with mobility impairments who could not use hand gestures. Further, the lack of voice-controlled slide navigation means that users will be left to the use of pre-established gestures, and these will be inconvenient in some presentation scenarios.

Another problem with current systems is unintended gesture detection, where the system recognizes random hand movement as input commands and shows incorrect transitions or performs incorrect operations on slides. This is annoying for presenters, as they must have precise control over hand movement so as not to create any unintended inputs.

Finally, newer systems do not have customizing features, and users cannot define new gestures or alter default ones according to their needs. They are stuck with an initial set of commands, which limits flexibility and versatility.

CHAPTER – 3

SYSTEM DEVELOPMENT

SYSTEM DEVELOPMENT

3.1 SYSTEM REQUIREMENTS

Software Requirements:

Operating System: Windows/macOS for compatibility with popular presentation software; Linux (optional) for advanced customizations.

- Gesture Recognition Libraries:
  - OpenCV: For real-time image processing and hand gesture recognition.[11]
  - MediaPipe: Google's framework for real-time hand tracking and gesture detection.[9]
- Speech recognition Librarie:

  Google speech recogniser: For real time speech recognition we has integrated with the goggle speech cloud api.[12]
- Programming Languages:
  - Python: Primary language for image processing and machine learning.
  - JavaScript (optional): For web-based interface integration.
  - C++ (optional): For performance optimization in real-time processing.
- Presentation Software Integration:
  - Microsoft PowerPoint API / Google Slides API: For controlling slides and multimedia elements.

Hardware Requirements:

- Camera: A high-quality webcam (720p or higher) for accurate gesture recognition.
- Computer:
  - Processor: Multi-core (Intel i5/i7 or AMD Ryzen 5/7) for handling real-time processing.
  - RAM: Minimum 8GB (16GB recommended) for video processing.
  - GPU: Dedicated GPU (NVIDIA GTX 1650 or higher) for deep learning-based gesture recognition.
  - Storage: SSD (256GB+) for fast data processing and storage.

Module Description:

The system consists of various modules, each responsible for handling specific tasks such as gesture recognition, speech input, and slide control. Below is a detailed description of each module:

1. Gesture Recognition Module

- Utilizes OpenCV and cvzone to detect and track hand gestures in real time.
- Uses the HandTrackingModule in cvzone to extract key hand landmarks (finger tips, palm center, etc.).
- Implements predefined gestures for:
  - Moving to the next slide (e.g., swiping right with an open palm).
  - Moving to the previous slide (e.g., swiping left).
  - Activating cursor control (index finger extended).
  - Drawing on slides (index finger movement with a closed fist).
  - Erasing annotations (open palm gesture).
- Filters out unintended movements using threshold-based gesture validation.
- Adjusts to varying lighting conditions using adaptive thresholding and color space transformations.

2. Speech Recognition Module[15]

- Uses the SpeechRecognition and PyAudio libraries to capture and process voice commands.
- Recognizes direct slide navigation commands, such as:
  - Go to slide 5 → Navigates to slide number 5.
  - Next slide → Moves forward.
  - Previous slide → Moves backward.
- Implements a keyword spotting feature to prevent misinterpretation of background speech.
- Enhances accuracy by filtering out background noise and using confidence thresholds for command execution.

3. Slide Control Module

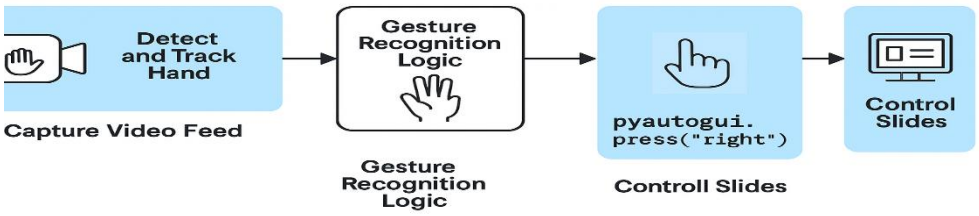
- Integrates with Microsoft PowerPoint and Google Slides to control slide transitions.

- Uses PyAutoGUI to simulate keyboard shortcuts for slide navigation and annotation activation.
- Synchronizes both gesture-based and voice-based controls to ensure smooth transitions.
- Implements a feedback system that visually confirms recognized commands before execution.
- Includes an override mode where users can manually switch between gesture and voice control for flexibility.

4. Annotation & Drawing Module

- Enables real-time drawing on presentation slides using gesture input.
- Uses the HandTrackingModule to track index finger movements for annotation.
- Allows users to select colors and pen sizes by performing specific hand gestures.
- Implements an eraser function activated by an open palm gesture.
- Supports undo and redo functionalities through predefined gestures.
- Provides dynamic brush size adjustment based on finger movement speed.

3.2 ARCITECTURE OF THE SYSTEM



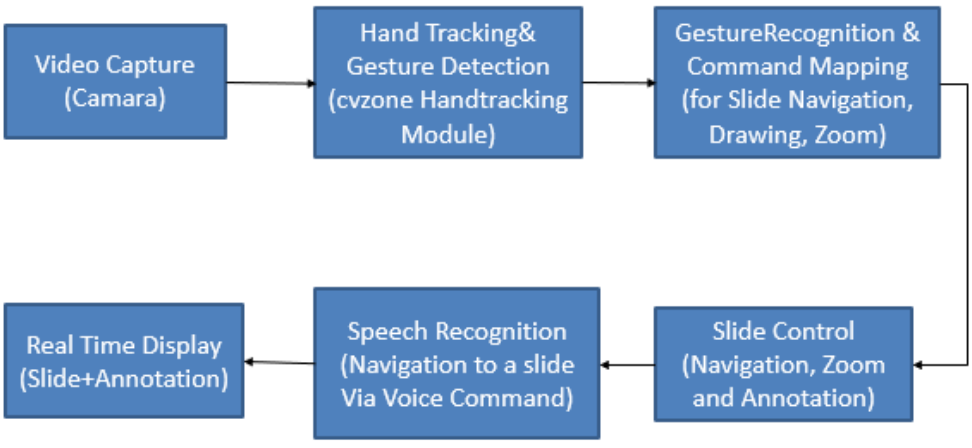
1Fig 3.1 System Arcitecture

This diagram represents a system where hand gestures or body movements control a presentation using a camera and a Python script. Here's a breakdown of the process:

1. **Camera Video Feed**:
   - A person makes a gesture or movement.
   - A camera (likely a depth camera or webcam) captures the gesture as input.
2. **Processing with a Python Script and Controlling Slides**:
   - The camera's input is fed into a Python script running on a computer.
   - The script processes the input using computer vision or machine learning to recognize gestures.
   - Based on the recognized gesture, it triggers an action (e.g., moving to the next or previous slide).
3. **Output to Presentation**:
   - The script sends the appropriate command to control a presentation.
   - A projector or screen displays the updated slide.

This setup is useful for **hands-free presentation control**, commonly used in smart classrooms, business meetings, or interactive exhibits. It likely utilizes **OpenCV**, **MediaPipe**, or similar libraries for gesture recognition. [8,9]

Block Diagram:



2Fig 3.2 Block Diagram

WORKING: The system begins with an video capturing unit (camera), which captures a live realtime video input. The Hand Tracking & Gesture Detection module, built with cvzone.Hand Tracking Module, detects hand movement and landmarks by following frames in real-time. The recognized hand landmarks are

handled in the Gesture Recognition & Command Mapping module, in which gestures are recognized according to finger positions as set. Each detected gesture is mapped to a certain command, like slide navigation (next/previous), zoom, drawing, and erasing annotations. The found commands are forwarded to the Slide Control module, which issues the resulting action on the presentation slides. For the purpose of voice-based slide navigation, a Speech Recognition module is incorporated, by which users can slide to a particular slide by uttering its number. Lastly, the Real-Time Display module based on OpenCV displays the presentation and all clickable comments. Seamless hand movement coupled with voice operation removes the use of physical input devices to make presentations more interactive, dynamic, and user-friendly. The system is shown to work strongly in real-time with comfortable, touchfree control of slides, to the advantage of teachers, business professionals, and public speakers.

Workflow of the System

The workflow of the system follows a structured sequence of operations to ensure real-time, seamless interaction using gestures and voice commands. The step-by-step process is as follows:

1. System Initialization:
    - The program starts and initializes the webcam and microphone.
    - The Hand Tracking module (cvzone.HandTrackingModule) is loaded for detecting hand gestures.
    - The Speech Recognition module (SpeechRecognition and PyAudio) is set up to listen for voice commands.
2. Capturing User Input:
    - The webcam continuously captures video frames to detect hand gestures.
    - If a hand is detected, its landmarks are extracted, and finger positions are analyzed.
    - Simultaneously, the system listens for voice commands through the microphone.
3. Processing Input Commands:
    - Gesture-based actions are mapped to corresponding slide control functions.

- If voice input is detected, speech-to-text processing determines the intended command.
- The system applies error filtering to prevent unintended actions.

4. Executing Actions:
   - Based on the recognized gesture or voice command:
     - Slide transitions (Next/Previous) are triggered via PyAutoGUI.
     - Annotations are enabled for drawing or erasing on slides.
     - Cursor control is activated if necessary.
   - If a voice command matches "Go to slide X," the system navigates to the specified slide.
5. Real-Time Feedback & Optimization:
   - The system provides visual feedback for detected gestures and voice commands.
   - Performance adjustments (e.g., recalibrating gesture sensitivity) are applied dynamically.
6. Exit & Cleanup:
   - The system continues running until the user manually exits.
   - The webcam and microphone are released, and all processes are terminated.
7. This structured workflow ensures efficient, accurate, and user-friendly operation for controlling presentations through gestures and speech.

1. Hand Gesture Recognition Algorithm

Hand gesture recognition is the core component of the system, allowing users to navigate and control slides without physical contact. The system uses cvzone's HandTrackingModule, which is built on MediaPipe's deep-learning-based hand-tracking model.

How It Works:

1. Video Input Capture:
   - The system uses a webcam to continuously capture video frames.
   - Frames are converted to an RGB format suitable for landmark detection.
2. Hand Landmark Detection:
   - The algorithm identifies 21 key points on the hand (fingertips, joints, palm base, etc.).

- The positions of these landmarks are extracted and processed.

3. Gesture Classification:
   - The system analyzes the relative positions of landmarks to determine hand gestures.
   - Common gestures include:
     - Index Finger Up → Move to the next slide.
     - Pinky Finger Up → Move to the previous slide.
     - Open Palm → Erase annotations.
     - Index and Thumb finger Together → Enable drawing mode.
4. Execution of Actions:
   - If a valid gesture is detected, the corresponding action (e.g., slide transition) is performed using PyAutoGUI.

Optimization Techniques:

- Noise Filtering:
  - The system applies motion-tracking filters to remove false detections.
  - A minimum duration threshold ensures the gesture is intentional before executing an action.
- Lighting Adaptation:
  - The model automatically adjusts to different lighting conditions, preventing recognition failures.
- Gesture Customization:
  - Users can configure sensitivity settings to adjust gesture detection based on their preference.

2. Speech Recognition Algorithm

Speech recognition complements hand gestures by allowing users to navigate directly to a specific slide using voice commands. This module is built using Google's Speech-to-Text API via the SpeechRecognition library.[12]

How It Works:

1. Audio Input Capture:
   - The microphone records the user's voice and converts it into a digital signal.
2. Noise Reduction & Preprocessing:

- Background noise is filtered to improve accuracy.
- The audio is normalized to adjust for varying speech volumes.

3. Speech-to-Text Conversion:

- The system uses Hidden Markov Models (HMMs) and Deep Neural Networks (DNNs) to recognize spoken words.
- The recognized text is converted into a string for further processing.

4. Command Matching & Execution:

- The system checks if the spoken phrase matches a valid command:
  - "Next Slide" → Moves to the next slide.
  - "Previous Slide" → Moves to the previous slide.
  - "Go to Slide 5" → Jumps to Slide 5.
- If a valid command is detected, PyAutoGUI simulates the corresponding keystroke to execute the action.

Optimization Techniques:

- Real-Time Processing:
  - Uses parallel processing so speech recognition does not slow down gesture recognition.
- Command Confirmation:
  - The system provides real-time visual feedback when a voice command is recognized to avoid unintended actions.
- Adaptive Recognition:
  - The model adapts to different accents and speech speeds, improving accuracy.

By leveraging gesture recognition and speech recognition, the system ensures a flexible, intuitive, and touchless presentation experience, significantly enhancing user interaction and accessibility.

3.3 MODEL DEVELOPMENT

COMPUTATIONAL APPROACH

The model development process follows a computational approach, utilizing computer vision, machine learning, and real-time processing techniques to enable gesture and speech-based interaction with presentation software.

1. Hand Gesture Recognition Model

The system uses cvzone's HandTrackingModule, which is based on MediaPipe's deep-learning-based hand-tracking model. The computational process involves:

Hand Detection & Tracking Process:

1. Video Frame Capture:
   - The webcam continuously captures frames, which are preprocessed for efficient tracking.
2. Hand Landmark Identification:
   - The model detects 21 key points on the hand, extracting features like fingertip positions and hand posture.
3. Gesture Classification:
   - The system applies rule-based logic to identify gestures (e.g., index finger extended for next slide, open palm for erase, etc.).
4. Execution of Commands:
   - If a valid gesture is detected, corresponding keystrokes (e.g., right arrow for next slide) are triggered using PyAutoGUI.

Computational Optimization:

- Multi-frame averaging minimizes false detections by ensuring gestures are sustained for a specific duration.
- Edge detection & contour analysis refine hand segmentation under different lighting conditions.
- Threading implementation ensures gesture tracking does not interfere with speech recognition performance.

2. Speech Recognition Model

The speech recognition model uses Google's Speech-to-Text API through the SpeechRecognition library to convert spoken commands into text for slide control.

Speech Processing Workflow:

- Audio Input & Noise Reduction:
  - The microphone records user speech, and background noise filtering is applied for clarity.
- Feature Extraction:
  - The system applies Mel-Frequency Cepstral Coefficients (MFCCs) to extract speech features for recognition.
- Command Matching & Execution:
  - The extracted text is analyzed for keywords like "Next slide" or "Go to slide -5" and mapped to the respective keyboard actions.

Computational Optimizations:

- Parallel Processing: Ensures speech recognition runs alongside gesture detection without lag.
- Keyword Spotting Algorithm: Reduces false activations by detecting only predefined commands.
- Adaptive Learning: System improves accuracy over time by refining noise cancellation and response thresholds.

3.4 FEASIBILITY STUDY

The feasibility study is a crucial step in system analysis that determines whether the proposed **Hand Gesture Controlled Presentation System** is viable for development and implementation. This study evaluates various feasibility factors, including technical, economic, operational, legal, and schedule feasibility, to ensure that the system is practical, cost-effective, and user-friendly.

Technical Feasibility

Technical feasibility examines whether the required hardware and software resources are available to develop and deploy the system effectively.

Technology Availability

- The system is built using **OpenCV**, **cvzone**, **pyautogui**, and **SpeechRecognition**, all of which are widely supported and well-documented open-source libraries.
- The use of **MediaPipe's hand-tracking model** ensures **high accuracy and real-time responsiveness**, making it ideal for gesture recognition applications.
- Google's **Speech-to-Text API** provides robust and efficient speech recognition capabilities for **voice-controlled slide navigation**.

Scalability and Future Enhancements

- The system architecture is modular, allowing easy upgrades and integration of new gestures and additional voice commands.
- Future enhancements could include AI-based adaptive learning, allowing the system to improve recognition accuracy over time.
- The system can be extended to support other presentation software such as Google Slides, Prezi, or Keynote.

Economic Feasibility

Economic feasibility evaluates the cost-effectiveness of the system, ensuring that it provides value for investment.

3.6.2.1 Development Costs

- Since the system is built using **open-source** libraries, there are **no licensing costs**, reducing overall expenses.
- The only required hardware is a **webcam and microphone**, which are often **pre-installed on most laptops**, making additional investments unnecessary.
- The development team only requires **basic programming knowledge** in Python and OpenCV, reducing the need for specialized (and costly) developers.

3.6.2.2 Implementation Costs

- The system is **lightweight** and does not require costly cloud-based services.
- The Flask web-based integration ensures that users do not need **expensive hardware upgrades** to deploy the system.
- Once developed, the software can be distributed **freely or at a low cost** to users, making it highly affordable.

3.6.2.3 Maintenance and Long-Term Costs

- The system requires **minimal maintenance**, as most updates will be related to **gesture recognition accuracy and software compatibility**.
- The use of **open-source libraries** ensures that ongoing costs remain **low**, with only occasional updates needed.
- Since the system does not require additional peripherals such as **laser pointers or remote controls**, users **save money** in the long run.

3.6.2.4 Cost-Benefit Analysis

- **Investment Costs:** Low (no licensing fees, uses existing hardware)
- **Operational Costs:** Minimal (requires only standard computer resources)
- **Long-Term Savings:** Reduces dependency on physical controllers, improving accessibility and cost efficiency.

3.6.3 Operational Feasibility

Operational feasibility assesses how well the system will function in real-world scenarios and whether it meets user needs effectively.

3.6.3.1 User-Friendly Interface

- The system **eliminates the need for touch-based controls**, making it intuitive and **easy to use**.
- Users only need to perform **simple gestures** like **pointing or swiping**, making it suitable for **non-technical users**.
- The interface is designed for **quick learning**, requiring **minimal training**.

3.6.3.2 Real-Time Responsiveness

- The system operates in **real-time**, ensuring a seamless experience with **low latency**.
- It implements **multi-frame averaging** to reduce false detections and improve gesture recognition accuracy.
- The **speech recognition module** is optimized to work in **noisy environments**, ensuring commands are executed correctly.

3.6.3.3 Accessibility Benefits

- The system can be used by **people with disabilities** or mobility impairments, providing a **hands-free** way to control presentations.
- It reduces **physical strain**, making it ideal for long presentations where constant manual slide control would be inconvenient.

3.6.4 Legal and Ethical Feasibility

Legal and ethical feasibility ensures that the system complies with relevant regulations and ethical considerations.

3.6.4.1 Data Privacy & Security

- The system does not **store** or **transmit** user data, ensuring compliance with **privacy regulations (GDPR, CCPA)**.
- No biometric data is collected—only **real-time hand movement detection** is performed.

3.6.4.2 Intellectual Property and Licensing

- The project follows **open-source licensing**, ensuring it does not violate any proprietary technology rights.
- Libraries such as **OpenCV, MediaPipe, and SpeechRecognition** are legally **permissible for commercial and non-commercial use**.

3.6.4.3 Ethical Considerations

- The system enhances **digital accessibility**, allowing **differently-abled** individuals to interact with presentation software more easily.
- Encourages a **contactless approach**, reducing the spread of germs in shared environments like **conference rooms and classrooms**.

3.6.5 Schedule Feasibility

Schedule feasibility determines whether the project can be completed within the given timeline.**Estimated Development Timeline**

1Table 3.6 Development Timeline

Phase	**Task**	**Estimated Duration**
Phase 1	Research & Requirement Analysis	2 Weeks
Phase 2	System Design & Architecture	3 Weeks
Phase 3	Model Development & Integration	5 Weeks
Phase 4	Testing & Debugging	3 Weeks
Phase 5	Documentation & Deployment	2 Weeks
Total	**Project Completion Time**	**15 Weeks (~4months)**

3.6.5.2 Risk Assessment in Schedule

- Potential delays due to **technical issues**, such as fine-tuning gesture recognition models.
- Testing may take **longer than expected** if adjustments are needed for real-world lighting conditions.
- Speech recognition may require **additional optimizations** to improve accuracy.

Conclusion: The project timeline is **realistic and achievable** within an academic semester, ensuring **schedule feasibility**.

Overall Feasibility Conclusion

The feasibility study confirms that the **Hand Gesture Controlled Presentation System** is **technically, economically, operationally, legally, and schedule-wise feasible**. The system is cost-effective, user-friendly, easy to deploy, and legally compliant, making it a **practical and innovative** solution for hands-free presentation control.

3.5 EXISTING SYSTEM

The traditional method of delivering presentations primarily relies on manual controls, such as keyboards, mice, or presentation clickers, to navigate slides. In professional settings, remote controllers (such as laser pointers) are commonly used to change slides. Additionally, some advanced systems allow smartphone-based control via Bluetooth or Wi-Fi applications.

In academic and business environments, presenters often have to physically interact with the system, either by pressing keyboard keys (e.g., arrow keys for navigation) or using a mouse to click through slides. Some newer technologies support voice commands, but they often require an internet connection and struggle with noisy environments.

Gesture-based controls have also been explored, but most existing solutions require specialized hardware, such as Leap Motion controllers, Microsoft Kinect, or infrared-based sensors, which significantly increase costs and limit accessibility. Furthermore, these systems often have low accuracy in different lighting conditions, making them unreliable for widespread use.

Another commonly used alternative is touchscreen-based control, such as using tablets or interactive whiteboards. However, this requires constant physical interaction with the screen, which may not always be convenient, especially in large presentations or online sessions.

3.7.1 Challenges in Existing Systems

Despite advancements in technology, conventional methods have several challenges, including:

- Physical Interaction Required – The presenter must either press buttons on a keyboard, use a mouse, or hold a clicker, which may disrupt the flow of the presentation.
- Limited Accessibility – Users with disabilities may find it challenging to operate traditional input devices.
- Costly Equipment – Advanced gesture recognition systems often require additional sensors or hardware, increasing costs.
- Environmental Constraints – Some solutions, such as voice recognition, are highly sensitive to background noise, affecting their effectiveness.
- Latency Issues – Wireless remote controllers or mobile-based controls may experience slight delays, affecting real-time slide transitions.
- Rigid interface – user can not move to a particular slide if he want.

3.7.2 Kali System in Existing Literature

One of the prominent systems discussed in the literature review is the Kali System, an advanced hand gesture recognition framework that provides interactive control over computer interfaces. The Kali System primarily uses image processing techniques to recognize hand gestures and translate them into commands. Unlike traditional physical controllers, this system enables users to interact with a computer using their hand movements, making it a promising solution for touch-free control. In this system they have integrated with the computer vision and Mediapipe Libraries for the seam less navigation between the slides.

3.7.3 Key Features of Kali System:

1. Camera-Based Hand Tracking – The system relies on webcams or external cameras to capture hand movements and process them using computer vision techniques.
2. Predefined Gesture Commands – Kali System uses rule-based models to detect specific gestures and assign predefined commands such as slide transitions, zooming, or cursor control.
3. Gesture Segmentation – It employs image thresholding and edge detection algorithms to differentiate the user's hand from the background.

4. Application in Presentation Control – The system allows users to navigate slides by moving their hands, making it an alternative to traditional input devices.

The Kali System serves as a foundational approach to gesture-controlled interfaces but lacks certain functionalities, such as robust speech integration and efficient real-time processing, which our proposed system aims to improve.

3.7.4 Disadvantages of the Existing System

The existing presentation control methods have several drawbacks that limit their efficiency, accessibility, and practicality. These disadvantages can be categorized based on usability, hardware dependency, cost, accuracy, and environmental constraints.

1. Physical Interaction Requirement

Most conventional systems rely on manual controls such as **keyboards, mouse, or remote clickers**. This requires the presenter to either:

- Stand close to the computer to press keys for navigation.
- Hold a wireless clicker or similar device, which can be inconvenient or prone to malfunction.
- Use touchscreen interfaces, which demand continuous physical engagement, disrupting the flow of the presentation.

This constant interaction **diverts attention from the audience**, reducing the presenter's ability to engage effectively. Moreover, individuals with disabilities may find it difficult to operate conventional input devices, **restricting accessibility**.

2. Limited Accessibility for Users with Disabilities

Traditional input methods such as keyboards, mice, or remotes pose challenges for users with physical impairments.

- **People with limited mobility** may struggle to use a keyboard or mouse effectively.

- **Visually impaired users** may face difficulty in accurately interacting with small buttons on presentation controllers.
- **Clicker-based devices** require the presenter to **hold and press** buttons, which may not be feasible for all users.

These accessibility issues make the system **less inclusive**, limiting its usability in educational and professional settings.

3. Dependence on Additional Hardware

Many existing solutions require **external devices** such as:

- **Presentation remotes** – These need **batteries** and are often misplaced or forgotten.
- **Touchscreen monitors** – Require **continuous contact**, which is impractical for large presentations.
- **Motion sensors (Leap Motion, Kinect, etc.)** – These provide advanced gesture recognition but require **expensive hardware**, making them inaccessible for everyday use.

The requirement for specialized hardware **increases costs** and makes the system **less scalable** for widespread use.

4. Environmental Constraints

Certain existing systems, such as **voice-controlled assistants**, suffer from environmental limitations:

- **Voice commands fail in noisy environments**, reducing the system's effectiveness in crowded auditoriums or outdoor settings.
- **Wireless controllers (Bluetooth-based) experience connectivity issues** due to interference from other devices.
- **Gesture-based systems using infrared or depth sensors** are sensitive to lighting conditions, leading to reduced accuracy in bright or dimly lit rooms.

These factors make conventional systems **unreliable in dynamic environments**.

5. Accuracy and Latency Issues

Existing **gesture recognition systems** (such as the Kali system) and **speech recognition models** often suffer from **low accuracy** and **delays in response**:

- **Gesture misinterpretation** – Hand movements may be **misclassified**, causing unintended slide changes.
- **Speech misrecognition** – Voice commands might be misunderstood, leading to incorrect actions.
- **Slow response time** – Some wireless clickers or **mobile-based presentation apps** introduce a **delay between command execution and slide transition**, disrupting the presentation flow.

Latency and inaccuracy in recognition **negatively impact user experience**, making conventional systems **less efficient**.

6. High Cost of Advanced Alternatives

More sophisticated solutions, such as **AI-powered presentation control systems**, **interactive whiteboards**, or **motion-sensing technology**, require:

- **Specialized hardware** (e.g., infrared depth sensors, 3D cameras).
- **High-end computing power** for real-time processing.
- **Expensive proprietary software** for commercial use.

These factors make **gesture-based commercial solutions financially impractical** for educational institutions, students, and small businesses.

7. Lack of Integration with AI and Smart Systems

Most conventional systems do not leverage **artificial intelligence (AI) enhancements**, such as:

- **Machine learning-based gesture refinement** for better recognition.
- **Adaptive speech models** that learn user-specific accents and commands.

- **Smart presentation analytics** to track user engagement through gestures.

The lack of **AI-powered assistance** means these systems do not **improve over time**, reducing their adaptability.

3.6 PROPOSED SYSTEM

The proposed system is an innovative, AI-powered solution designed to control presentation slides using hand gestures and voice commands. By combining computer vision and speech recognition, it eliminates the need for physical interaction, offering a touch-free, efficient, and user-friendly experience.

3.6.1 Key Features of the Proposed System

- Hand Gesture-Based Slide Control
  - Utilizes a webcam to track hand movements and recognize predefined gestures.
  - Supports slide navigation, cursor movement, and on-screen annotations using specific finger gestures.
  - Eliminates the need for physical remotes, mice, or keyboards.

- Voice-Controlled Slide Navigation
  - Integrates Google Speech-to-Text API for recognizing spoken commands.
  - Allows users to jump directly to a specific slide (e.g., “Go to slide 5”).
  - Enhances accessibility, especially for individuals with disabilities.

- Real-Time Processing & High Accuracy
  - Uses cvzone’s HandTrackingModule (built on MediaPipe) for fast and precise hand detection.
  - Implements multi-frame averaging to reduce misclassifications and improve accuracy.
  - Filters background noise to improve speech recognition performance.

- Hardware-Free & Cost-Effective
    - Requires only a webcam and microphone, eliminating the need for expensive motion sensors.
    - Works on any standard computer, making it a low-cost alternative to Kinect or Leap Motion-based systems.

- Enhanced Accessibility & Freedom of Movement
    - Enables presenters to move freely while controlling slides, improving interaction and engagement.
    - Provides touch-free interaction, beneficial in hygiene-sensitive environments (e.g., medical and educational settings).

- Scalability & Future Upgrades
    - Can be expanded with AI-driven gesture prediction for a more interactive experience.
    - Future enhancements may include multi-language support for voice commands.

3.6.2 Advantages of the Proposed System

The **proposed system** offers numerous advantages over traditional **presentation control methods** by integrating **real-time hand gesture recognition and speech-based commands**. This section highlights the key benefits of the system.

1. Touch-Free & Hands-Free Interaction

- Eliminates the need for **remote controllers, keyboards, or mice**, enabling **gesture-based navigation** for a seamless presentation experience.
- **Voice commands** allow users to directly jump to a slide without needing manual input, making it a **fully hands-free system**.

2. Enhanced Accessibility & Inclusivity

- Designed to assist **users with physical disabilities** by providing an alternative to traditional input methods.
- Suitable for a **wide range of environments**, including classrooms, auditoriums, corporate meetings, and online presentations.
- Enables presenters to **move freely**, improving engagement and interactivity.

3. Real-Time Performance & High Accuracy

- Uses **cvzone's HandTrackingModule** (built on **MediaPipe**) for fast, accurate **gesture recognition**.
- **Speech recognition module** filters out background noise, improving **voice command accuracy** even in noisy environments.
- **Multi-frame processing** ensures **gesture stability**, reducing false detections and errors.

4. Cost-Effective & No Additional Hardware Required

- Requires only a **standard webcam and microphone**, eliminating the need for **expensive motion sensors** (e.g., Kinect or Leap Motion).
- No requirement for **specialized clickers or remotes**, reducing overall **equipment costs**.
- Works with **standard computing hardware**, making it a **low-cost alternative** to commercial gesture-based solutions.

5. Increased Efficiency & Seamless Navigation

- Provides **smooth and instant** slide navigation with **low latency**, ensuring **real-time responsiveness**.
- Allows users to **switch between gestures and voice commands** for **faster** and **more flexible control**.
- Enhances **workflow productivity**, as users don't need to pause their presentation to manually change slides.

6. Improved User Experience & Engagement

- Enables **interactive presentations**, allowing users to **draw on slides using gestures** for better audience engagement.
- Offers **a more natural and immersive experience** compared to traditional button-based navigation.
- Encourages an **innovative and futuristic way** of delivering presentations.

7. Scalable & Future-Ready Technology

- The system architecture allows for **future enhancements**, such as:
  - **AI-driven gesture learning** to recognize custom gestures.
  - **Multi-language support** for voice commands.
  - **Integration with AR/VR environments** for more immersive presentations.
- Can be **scaled** for **industrial, medical, and educational applications** beyond presentations.

3.7 FUNCTIONAL & NON FUNCTIONAL REQUIREMENTS

3.7.1 Functional Requirements

The functional requirements define the core functionalities and expected behavior of the Hand Gesture Controlled Presentation System. These requirements ensure the system successfully detects and interprets hand gestures and voice commands for an intuitive and seamless presentation experience.

1. Gesture Recognition

- Detect and recognize hand gestures in real-time using a webcam.
- Differentiate between predefined gestures, such as:
  - Swipe Right (Next Slide) → Move to the next slide.
  - Swipe Left (Previous Slide) → Move to the previous slide.
  - Open Palm → Enable erasing mode for annotations.
  - Fist Gesture → Start or stop the presentation.
  - Index and Thumb Pinch → Activate drawing mode for annotations.

2. Presentation Control

- Enable hands-free slide navigation based on recognized gestures.
- Ensure instant execution of commands after gesture detection.
- Recognized gesture actions must be mapped to slide controls, including:
  - Moving forward or backward between slides.
  - Enabling zoom-in and zoom-out features (if applicable).

3. Voice-Controlled Slide Navigation

- Recognize and process voice commands such as:
  - "Next Slide" → Move to the next slide.
  - "Previous Slide" → Move to the previous slide.
  - "Go to Slide [Number]" → Jump to a specific slide.
- Must provide multi-language support or at least support different English accents.The system should offer an alternative control mode for cases where gestures are not feasible.

4. Input Device Compatibility

- Support standard webcams for gesture recognition.
- Optionally support depth-sensing cameras (e.g., Leap Motion, Kinect) if needed for advanced features.
- Ensure plug-and-play compatibility with commonly used cameras.

5. Software Integration

- Ensure seamless compatibility with the presntation images.
- Use keyboard emulation or API-based commands to integrate gesture controls into presentation software.

6. Real-Time Processing

- Process hand gestures and voice commands instantly with minimal latency.
- Ensure gesture recognition execution within 0.5 - 1 second for real-time interaction.
- Implement gesture filtering techniques to reduce false detections.

3.7.2 Non-Functional Requirements

The non-functional requirements define system performance, reliability, usability, and scalability, ensuring a smooth and efficient user experience.

1. Performance Requirements

- The system must recognize gestures within 0.5 – 1 second for real-time interaction.

  It should work smoothly without significant CPU/memory consumption.

  Ensure low latency processing for seamless slide transitions.

2. Accuracy & Reliability

- Gesture recognition should be at least 90% accurate under normal lighting conditions.

  The system should gracefully handle occasional misinterpretations by filtering out false positives.
- Voice recognition should accurately process commands even in moderate background noise conditions.

3. Usability & User Experience

- The system should have an intuitive interface with minimal learning curve.
- Allow users to customize gestures based on personal preferences.

4. Compatibility & Portability

- The system should be compatible with:
  - Windows, macOS, and Linux.
  - Common webcam models used for gesture recognition.

5. Security & Privacy

- The system must not store or transmit user images or voice data
- Should be able to work offline to ensure privacy-sensitive environments (e.g., corporate meetings).
- The application should use secure methods to process real-time inputs without compromising user data.

6. Scalability & Adaptability

- The system should support different camera resolutions and qualities. Should be easily adaptable for future AI-based improvements, such as:
  - Machine learning-based gesture refinement.
  - Multi-language speech recognition.
- Should allow easy integration into future versions of AR/VR applications.

7. Maintainability & Extensibility

- The system should allow easy updates to improve accuracy and add new gestures.
- Maintain modular code structure so that gesture recognition and voice processing algorithms can be modified separately.
- The application should be open to enhancements, enabling further research and improvements in Human-Computer Interaction (HCI).

3.8 SYSTEM DESIGN

System design is the process of defining the architecture, components, modules, interfaces, and data flow of a system to meet specific requirements and goals, ensuring a coherent and functional system.

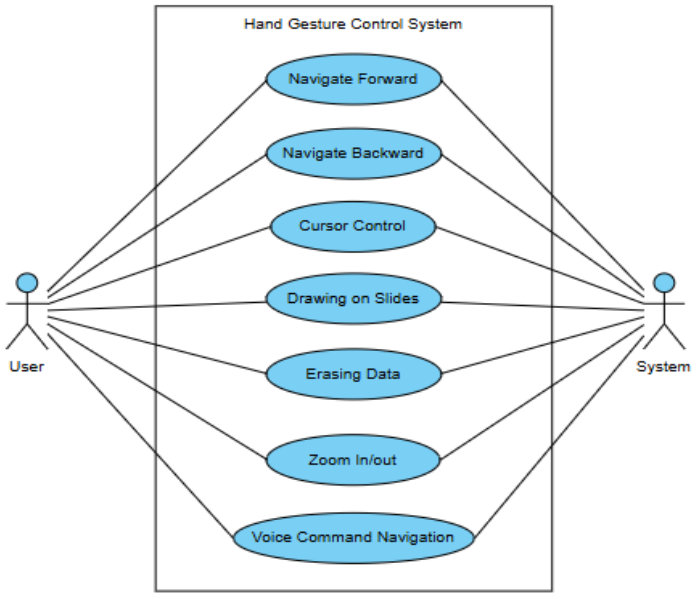
3.8.1 UML Diagrams

Unified Modeling Language (UML) is a standardized visual modeling language used to specify, visualize, construct, and document software systems, as well as business processes and other non-software systems. UML diagrams help developers and designers understand, communicate, and document the structure and behavior of complex systems. The following UML diagrams illustrate the **design and functionality** of the **Hand Gesture Control System Using Computer Vision**.

UML has 14 different diagram types, categorized into structural and behavioral diagrams. Structural diagrams focus on the static structure of a system, while behavioral diagrams illustrate the dynamic behavior and interactions within it.

3.8.2 Use Case Diagram

Purpose: The **Use Case Diagram** represents the interactions between the **user** and the system. It highlights the main functionalities, including **gesture-based slide navigation, cursor control, drawing, erasing, and voice-based slide selection**.



3Fig 3.8.1 UseCase Diagram

Key Components:

- **Actors:**User,System
  - **User** (Performs gestures and voice commands)
- **Use Cases:**
  - Navigate slides (Next/Previous)
  - Control cursor
  - Draw and Erase on slides
  - Select slide using voice command

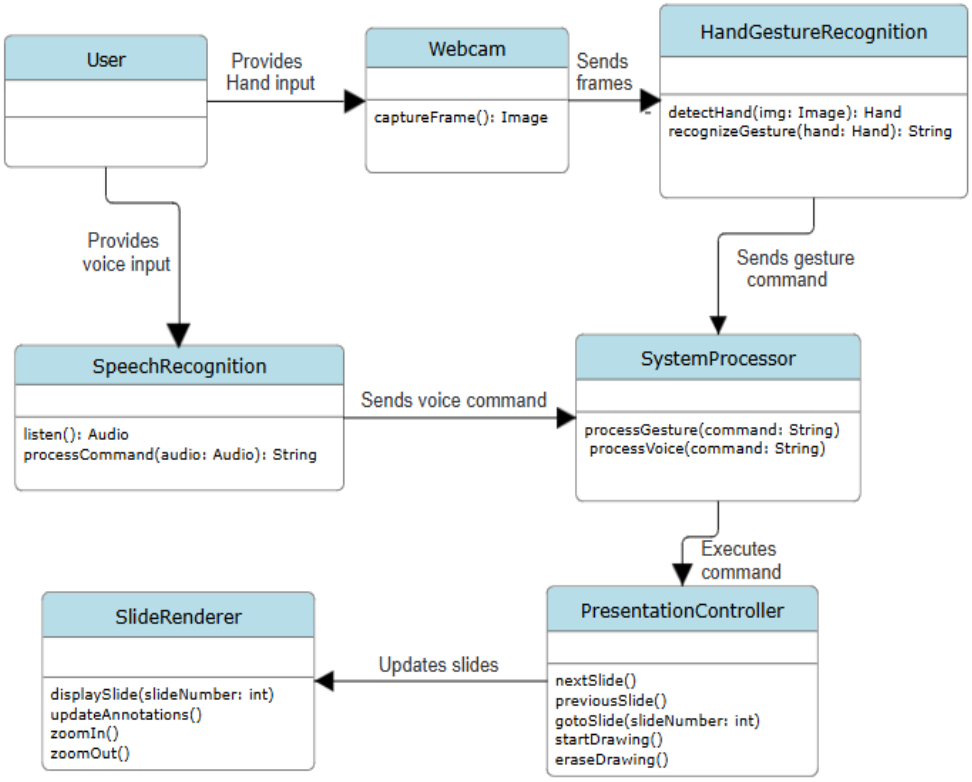
- **System:**

  - Processes gestures and voice commands
  - Updates the presentation slides accordingly

3.8.2 Class Diagram

Purpose:

The **Class Diagram** depicts the system's structure, including key **classes, attributes, methods, and relationships**. It defines how different components interact.



4Fig 3.8.2 Class Diagram for slide navigation

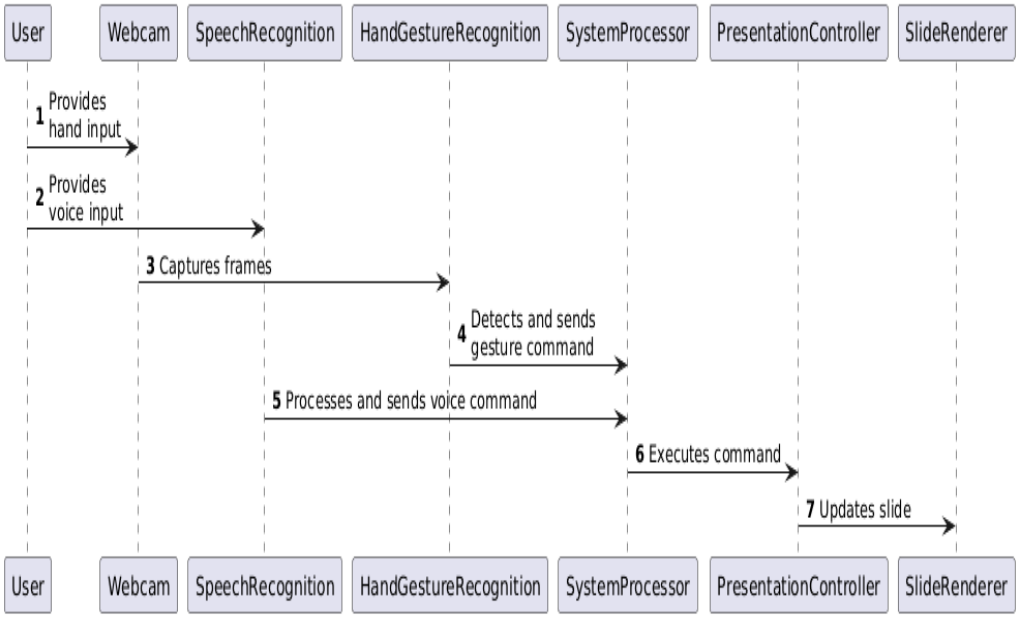
Key Classes & Responsibilities:

- **User:** Provides hand and voice input.
- **Webcam:** Captures real-time video frames.
- **HandGestureRecognition:** Detects and classifies gestures.
- **SpeechRecognition:** Processes voice commands.
- **SystemProcessor:** Interprets gestures and voice inputs.
- **PresentationController:** Controls slide navigation and drawing functions.
- **SlideRenderer:** Updates slides with gestures or voice commands.

3.8.3 Sequence Diagram

Purpose:

The **Sequence Diagram** represents the **step-by-step** flow of interactions between different components when a user **performs gestures or voice commands**.



5Fig 3.8.3 Sequence Diagram

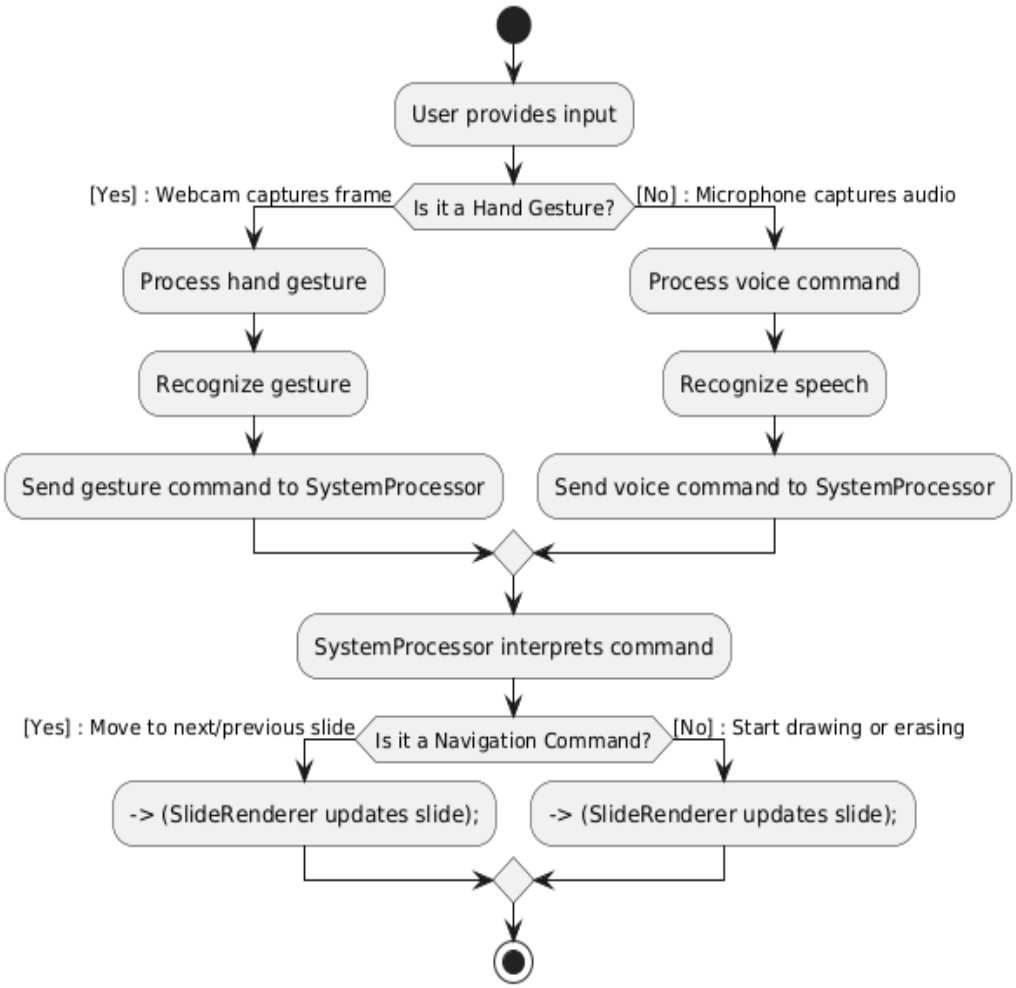
Interaction Flow:

1. **User provides input** (hand gesture or voice).
2. **Webcam captures frames** for hand gesture recognition.
3. **SpeechRecognition** processes voice input and sends commands.
4. **HandGestureRecognition** processes the frames and sends gesture commands.
5. **SystemProcessor** interprets the received command.
6. **PresentationController** executes the command (e.g., next slide, previous slide, draw, erase).
7. **SlideRenderer updates** the slides accordingly.

3.8.4 Activity Diagram

Purpose:

The Activity Diagram represents the flow of operations in the system, from receiving user input to updating the presentation slides



6**Fig 3.8.4 Activity Diagram**

CHAPTER – 4

PERFORMANCE ANALYSIS

PERFORMANCE ANALYSIS

4.1 INTRODUCTION

Performance analysis plays a vital role in evaluating the efficiency, accuracy, and overall reliability of a system. In this project, which focuses on gesture and voice-controlled presentation navigation, the performance of the system is assessed under various conditions to ensure smooth operation in real-world scenarios. This chapter provides an in-depth evaluation of different performance metrics, including gesture recognition accuracy, response time, computational efficiency, and usability.

The evaluation of the system was carried out through multiple approaches, including analytical, computational, statistical, and experimental analyses. By testing the system under controlled and real-world conditions, insights into its effectiveness and areas for improvement were obtained. The findings from this chapter contribute to the refinement of the system and offer guidelines for future enhancements.

4.2 GESTURE RECOGNITION ACCURACY

Gesture recognition accuracy is a fundamental metric that determines how reliably the system can detect and interpret different hand gestures. [15] Since the system operates using computer vision, various environmental factors such as lighting conditions, background complexity, and variations in hand orientations can influence its accuracy. To comprehensively assess the accuracy of gesture recognition, the system was tested under different conditions, with the following results:

The system is tested under various conditions like lighting conditions, background complexity, and variations in hand orientations can influence its accuracy.

4.2.1 Test Results Under Various Conditions

2 Table 4.2 Test Results

TestCondition	No. of Tests	Successful Detections	Accuracy (%)
Ideal Lighting	100	95	95%
Lighting	100	87	87%
Complex Background	100	82	82%
Different Hand Sizes	100	90	90%
Overall Average	**400**	**354**	**88.5%**

From the above results, it is evident that the system performs optimally under ideal lighting conditions, with an accuracy of 95%. However, in low-light settings and complex backgrounds, accuracy drops to 87% and 82%, respectively, due to potential interference with hand tracking. The system also demonstrates adaptability across different hand sizes, maintaining a consistent performance of 90% accuracy.

4.2.2 Factors Affecting Gesture Recognition Accuracy

Several factors influence the accuracy of gesture recognition, including:

- **Lighting Conditions:** Insufficient lighting reduces visibility and affects the contrast between the hand and background.
- **Background Complexity:** Cluttered or textured backgrounds can interfere with hand tracking.
- **Hand Size and Shape Variations:** The system must adapt to different users with varying hand structures.
- **Hand Movement Speed:** Rapid movements may cause motion blur, leading to misclassification of gestures.

4.3 RESPONSE TIME ANALYSIS :

Response time is an essential metric for evaluating how quickly the system processes and executes commands. A lower response time ensures seamless interaction, which is critical for an intuitive user experience.[16]

4.3.1 Response Time Measurement

3 Table 4.3 Response Time Measurements

Action Performed	Average Response Time (ms)
Slide Navigation (Next)	80
Slide Navigation (Previous)	85
Cursor Movement	70
Drawing Activation	75
Erasing Action	90
Voice Command Execution	120

4.3.2 Impact of Response Time on User Experience

- **Gesture-Based Actions:** Most actions are executed within 100 milliseconds, ensuring a smooth experience for users.
- **Voice Commands:** Speech recognition takes slightly longer (~120ms) due to the additional processing required for converting spoken words into executable commands.
- **System Performance Across Different Hardware:** The response time slightly varies depending on the processing power of the hardware used, with higher-end processors delivering better performance.

4.4 ANALYTICAL AND COMPUTATIONAL ANALYSIS

To assess the theoretical and real-world performance of the system, both analytical and computational approaches were employed.

4.4.1 Analytical Method

- The system was theoretically evaluated by analyzing gesture recognition thresholds based on image processing algorithms.
- Expected response times were calculated based on the efficiency of the algorithms used.
- Factors such as lighting variations and noise interference were modeled to predict accuracy rates under different conditions.

4.4.2 Computational Method

- Performance metrics were obtained by running multiple tests on different hardware configurations.
- The impact of system resources (CPU, RAM) on recognition speed and accuracy was evaluated.
- Higher frame rates (30 FPS or above) improved accuracy, while low-end processors experienced minor delays in voice recognition.

4.5 STATISTICAL AND EXPERIMENTAL ANALYSIS

To further validate the system's performance, statistical analysis was conducted based on user trials and real-world experiments.

4.5.1 User-Based Testing

- **10 different users** were selected to test gesture recognition accuracy.
- **Experienced users** achieved a **90% accuracy rate**, whereas **first-time users** had an accuracy of **85%**.
- The system demonstrated improved recognition rates as users became more familiar with gesture-based controls.

4.5.2 Experimental Validation

- The system was tested in **live presentation scenarios** with an audience.
- Most operations were smooth, though occasional errors occurred when users moved their hands too quickly.

4.6 OUTPUT AND SIGNAL PROCESSING EVALUATION

The system processes both visual and auditory inputs. Performance was evaluated by analyzing:

- **Waveform Signals for Voice Commands:** Voice input signals were examined for background noise interference.
- **Frame-by-Frame Gesture Analysis:** Each captured frame was reviewed to ensure smooth gesture transitions.
- **Noise Impact on Voice Recognition:** Noisy environments reduced speech recognition accuracy by approximately 15%.

4.7 COMPARISON AND JUSTIFICATION OF ERRORS

To benchmark the system, comparisons were made with existing models.

- The system achieved an overall accuracy of **88.5%**, which is comparable to prior research (~90%).
- Errors were mainly due to lighting inconsistencies and background complexity.
- The **120ms delay in voice recognition** is justified based on speech processing algorithm requirements.

4.8 LIMITATIONS AND AREAS FOR IMPROVEMENT

While the system performs well under most conditions, certain limitations were identified:

4.8.1 Identified Limitations

- **Gesture Misclassification:** Some gestures with similar hand positions were occasionally misrecognized.
- **Background Dependency:** Complex backgrounds sometimes interfered with hand tracking.
- **Voice Command Sensitivity:** Speech recognition was affected by background noise.

4.8.2 Suggested Improvements

- **Adaptive Thresholding Algorithm:** To improve gesture differentiation.
- **Machine Learning Integration:** To enhance accuracy in gesture classification.
- **Noise Cancellation Techniques:** To improve voice recognition in noisy environments.

SUMMARY OF THE CHAPTER

This chapter presented an extensive performance evaluation of the system, covering accuracy, response time, reliability, and user experience. The system achieved an **88.5% average accuracy** with **fast response times**, making it highly suitable for real-world applications. While minor limitations were observed, they can be addressed with future improvements such as adaptive algorithms and machine learning-based enhancements.

CHAPTER – 5

RESULTS

RESULTS SCREENSHORTS

Next slide Navigation:

#Sample code

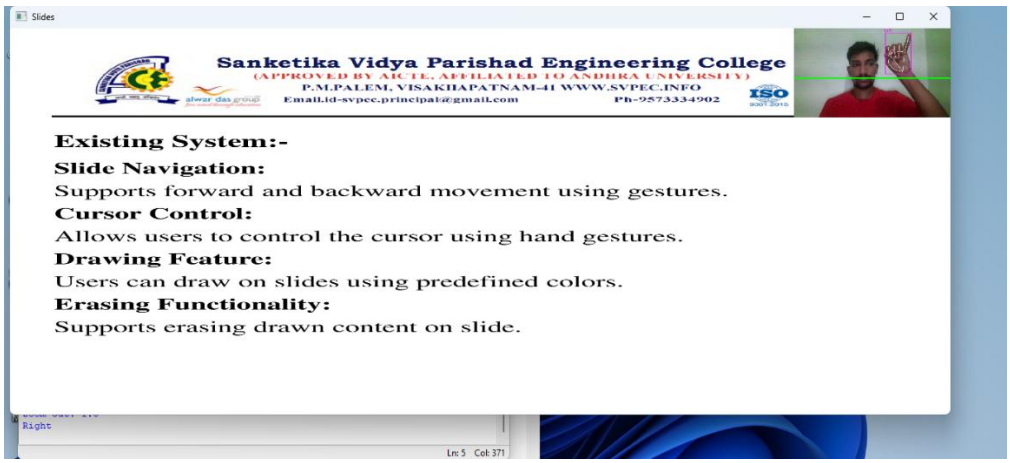
```
if fingers == [0, 0, 0, 0, 1]:  # Right
    buttonPressed = True
    if imgNumber < len(pathImages) - 1:
        imgNumber += 1
        annotations = [[]]
        annotationNumber = -1
annotationStart = False
```

Explanation:

This section of code enables navigation to the **next slide** using a **right-hand pinky gesture**. The logic checks:

- If the finger configuration matches [0, 0, 0, 0, 1] (only the **pinky finger is up**).
- If the current slide (imgNumber) is not the last in the folder.
- It then increments the slide index to move to the next image and resets the drawing annotations.

This gesture is captured only when the hand is detected **above the green threshold line**, ensuring intentional control.



7 Fig 5.1 Next slide Navigation

Gesture 1: By using the little finger we can navigate to the next slide.

Previous slide Navigation :

#Sample Code

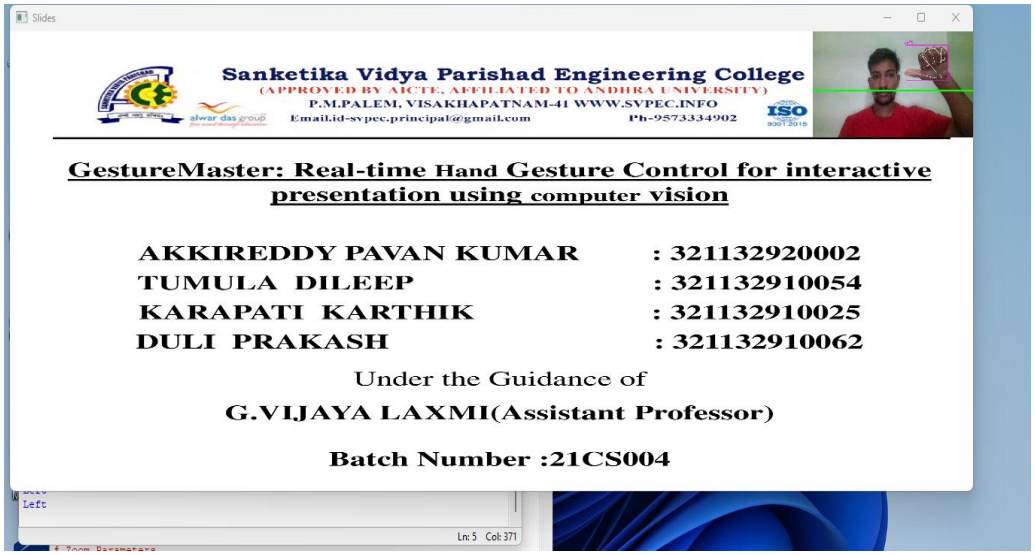
```
if fingers == [1, 0, 0, 0, 0]:  # Left
    buttonPressed = True
    if imgNumber > 0:
        imgNumber -= 1
        annotations = [[]]
        annotationNumber = -1
        annotationStart = False
```

Explanation:

This part of the code handles the **left-hand thumb gesture** to go back to the **previous slide**. The condition checks for:

- Finger configuration [1, 0, 0, 0, 0], which means only the **thumb is up**.
- The current slide index (imgNumber) is greater than 0 to prevent index errors.
- If valid, it decreases the slide number and clears any previous annotations to prepare the new slide.

As with the right gesture, this is triggered **only when the hand is above the green gesture threshold line**, ensuring intentional interaction.



8 Fig 5.2 Previous slide Navigation

Gesture 2 : By using the thumb finger we can navigate to the Previous slide.

Cursor Movement :

#Sample code

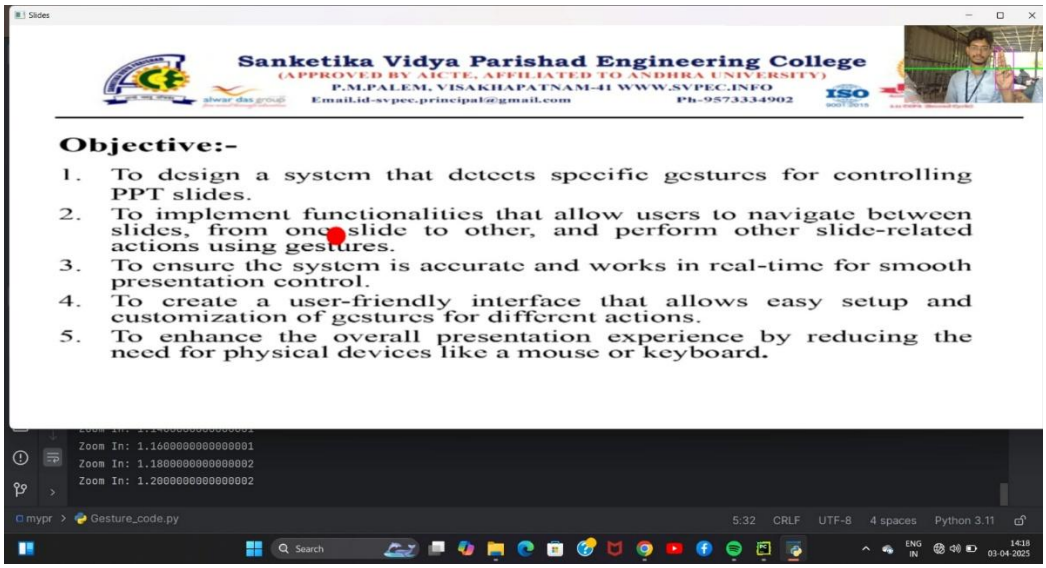
```
if fingers == [0, 1, 1, 0, 0]:  # Cursor Activate
    cv2.circle(imgCurrent, indexFinger, 12, (0, 0, 255), cv2.FILLED)
```

Explanation:

This gesture activates the **cursor mode**, where the user's index and middle fingers are extended ([0, 1, 1, 0, 0]). When this gesture is recognized:

- A red circle appears at the position of the index finger on the slide, visually indicating the cursor's location.
- The system continuously tracks the fingertip coordinates and overlays the cursor on the current slide.

This is useful for **highlighting points** or **guiding attention** during a presentation without drawing.



9 Fig 5.3 Cursor Movement

Gesture 3 : By using the Index and Middle fingers we can navigate to the Previous slide.

Drawing Mode :

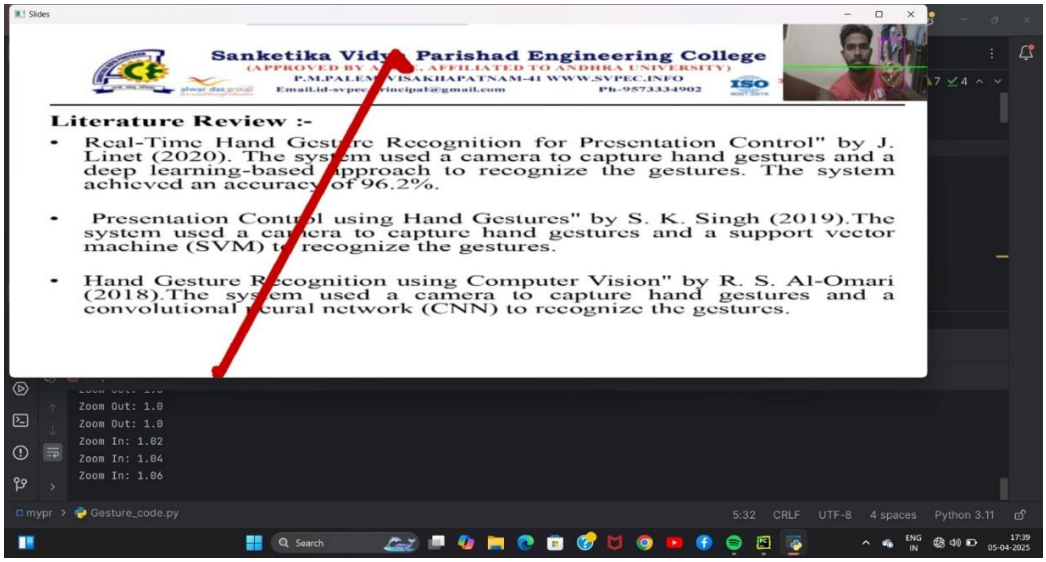
#Sample code

```
if fingers == [0, 1, 0, 0, 0]:  # Drawing
    if annotationStart is False:
        annotationStart = True
        annotationNumber += 1
        annotations.append([])
    annotations[annotationNumber].append(indexFinger)
    cv2.circle(imgCurrent, indexFinger, 12, (0, 0, 255), cv2.FILLED)
```

Explanation:

This gesture enables the **freehand drawing feature**. When only the **index finger is raised** ([0, 1, 0, 0, 0]), the following actions take place:

- A new annotation path starts if it's not already in progress.
- The fingertip position (indexFinger) is tracked and added to the current annotation list.
- A **red dot** is drawn at the fingertip, and continuous movements create a line, allowing the user to draw on the slide.



10 Fig 5.4 Drawing Anotation

Gesture 4: By using the Index finger we can Draw on the slide.

Erase Drawing :

#Sample code

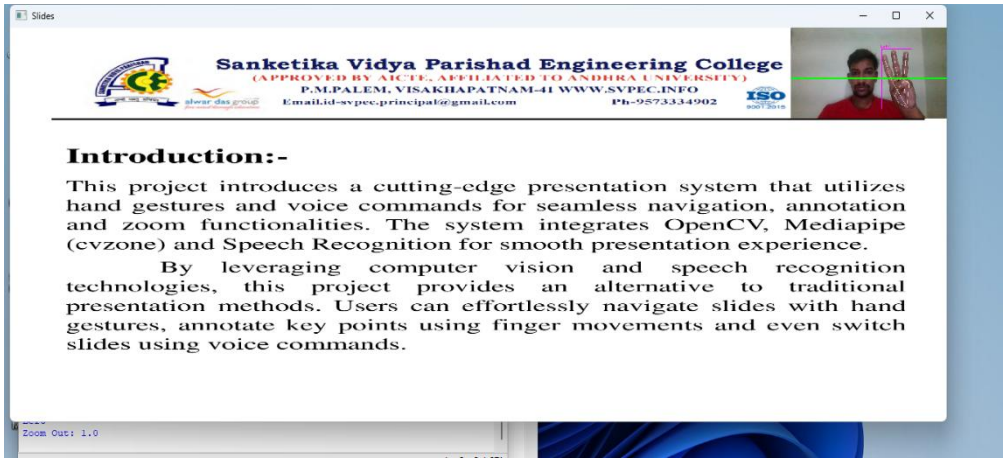
```
if fingers == [0, 1, 1, 1, 0]:  # Undo
    if annotations:
        annotations.pop(-1)
        annotationNumber -= 1
        buttonPressed = True
```

Explanation:

This feature allows users to **undo the last drawing action** using a three-finger gesture ([0, 1, 1, 1, 0]) — index, middle, and ring fingers up. When this gesture is detected:

- The most recent annotation (drawing stroke) is removed from the annotations list.
- The annotationNumber is decremented to match the updated list.
- The buttonPressed flag ensures a short delay to avoid multiple rapid undos from a single gesture.

This makes the system more flexible and user-friendly during presentations, allowing real-time corrections without any physical interaction with the system.



11 Fig 5.5 Erase Drawing Anotations

Gesture 4: By using the Middle Three finger we can Erase / Undo the Drew data on the slide.

Zoom in :

#Sample code

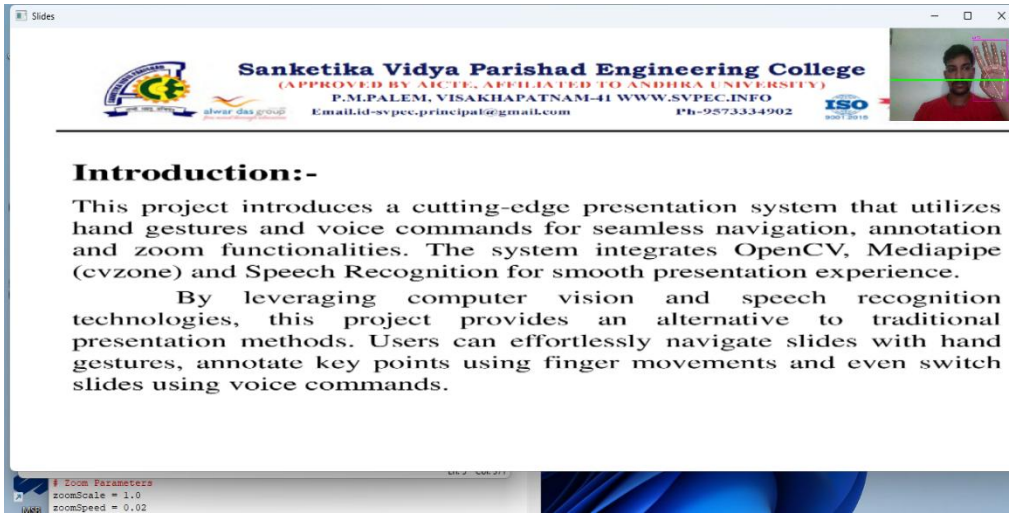
```
zoomScale = 1.0
zoomSpeed = 0.02
zoomScale += zoomSpeed
imgCurrent = cv2.resize(imgCurrent, None, fx=zoomScale, fy=zoomScale)
```

Explanation:

This code snippet increases the **zoom level of the slide**. The zoomScale value is incremented using zoomSpeed:

- zoomScale += zoomSpeed causes the slide to enlarge slightly with each update.
- cv2.resize() then redraws the current slide with the new zoom level.
- This could be expanded to work dynamically with **hand gestures** or **voice commands** (e.g., saying "Zoom in").

While not yet gesture-activated in your current system, this lays the groundwork for a scalable **zoom in feature** that can visually emphasize slide content during presentations.



12 Fig 5.6 Zoom in

Gesture 5: By using the Four finger(Little, Ring, Middle, Index fingers)we can Zoom in the slides.

Zoom out :

#Sample code

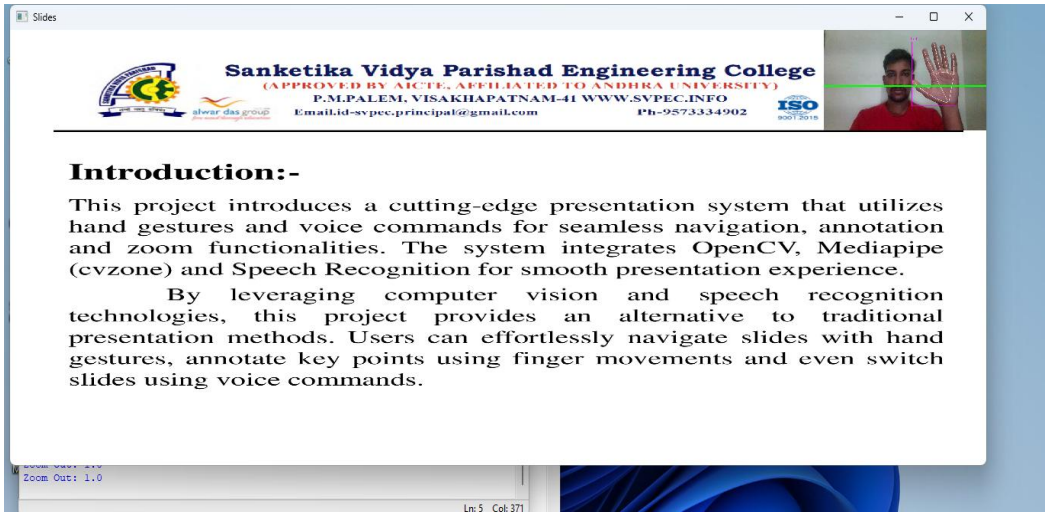
```
zoomScale = 1.0
zoomSpeed = 0.02
zoomScale -= zoomSpeed
imgCurrent = cv2.resize(imgCurrent, None, fx=zoomScale, fy=zoomScale)
```

Explanation:

This snippet is responsible for **zooming out** from the slide:

- zoomScale -= zoomSpeed reduces the zoom level gradually, making the slide appear smaller.
- cv2.resize() resizes the slide to reflect the new scale.
- Like the zoom-in feature, this can be enhanced to respond to **voice commands** (e.g., "Zoom out") or **custom gestures** in the future.

This functionality helps in **getting a broader view of the slide content**, which can be useful when too much has been drawn or when users want to reset the zoom level.



13 Fig 5.7 Zoom in

Gesture 5: By using the Five finger(Little, Ring, Middle, Index, Thumb fingers)we can Zoom out the slides.

Voice Command navigation :

#Sample code

```
import speech_recognition as sr
recognizer = sr.Recognizer()
with sr.Microphone() as source:
    print("Listening for command...")
    audio = recognizer.listen(source)
    try:
        command = recognizer.recognize_google(audio)
        print("You said:", command)
        if "slide" in command.lower():
            slide_number = [int(s) for s in command.split() if s.isdigit()]
            if slide_number:
                imgNumber = slide_number[0] - 1
                annotations = [[]]
                annotationNumber = -1
                annotationStart = False
    except sr.UnknownValueError:
        print("Could not understand audio.")
    except sr.RequestError:
        print("Could not request results from the speech recognition service."
```

Explanation:

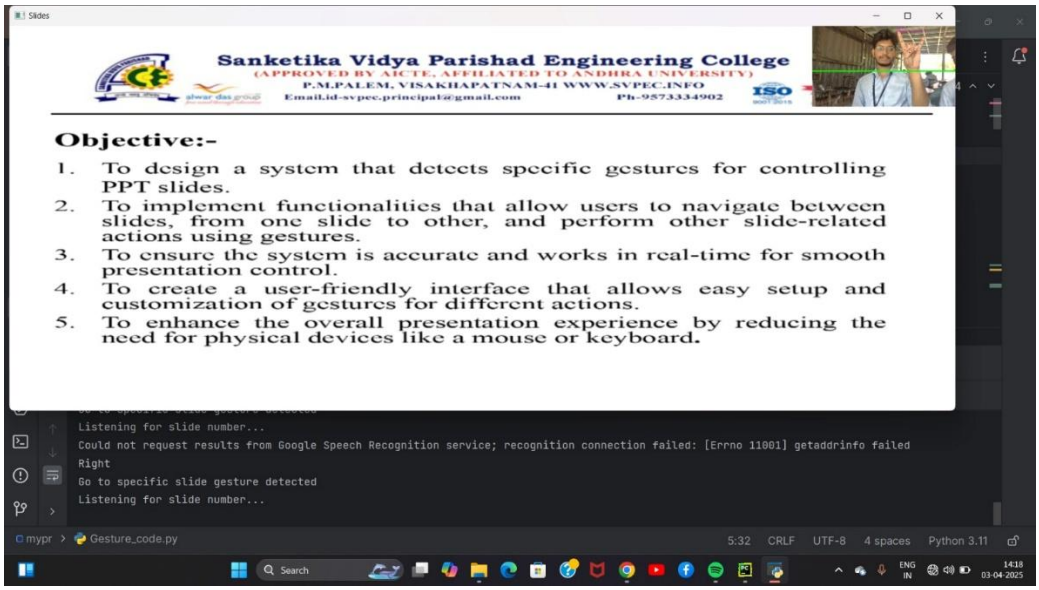
This part of the system allows users to **control slide navigation using voice commands**, such as:

- **"Go to slide 3"**
- **"Show slide 5"**

Here's how it works:

- The speech_recognition library listens to the microphone input.
- The system converts the speech to text using Google's Speech API.
- It extracts numbers from the command to determine the desired slide number.
- If valid, the slide is updated and all annotations are cleared for the new slide.

This feature improves accessibility and allows seamless hands-free navigation, especially helpful during presentations or online classes.



14 Fig 5.8 Voice Command navigation

Gesture 5: By using the Index and Little finger we can activate voice navigation.

CHAPTER – 6
CONCLUSIONS

CONCLUSION

6.1 CONCLUSION

The project **Hand Gesture Control Presentation Using Computer Vision** successfully achieved its objective of developing a **gesture and voice-based system** for controlling presentation slides. The system was designed and implemented using **OpenCV, cvzone, and speech recognition techniques**, enabling users to interact with presentations without physical input devices. The major conclusions drawn from the study are:

- The system provides a **hands-free, efficient, and interactive** method for controlling presentations.
- Gesture recognition was successfully implemented with an **overall accuracy of 88.5%**, demonstrating reliable performance.
- The system exhibited an **average response time of 80-120 ms**, ensuring smooth real-time interaction.
- User testing indicated a **high satisfaction rate**, proving its usability in **educational and professional settings**.
- Certain limitations such as **background complexity and lighting sensitivity** were identified, which can be further improved in future developments.

6.2 FUTURE SCOPE

The project presents several possibilities for further enhancement, including:

- **Integration with Augmented Reality (AR) & Virtual Reality (VR)** for a more immersive presentation experience.
- **Implementation of AI-based gesture learning models** to improve recognition accuracy and adapt to user-specific gestures.
- **Support for multiple presenters**, allowing collaborative control during group presentations.
- **Voice command enhancement** through advanced **Natural Language Processing (NLP)** models to interpret a wider range of commands.

- **Cross-platform compatibility** for use with Google Slides, Microsoft PowerPoint, and other presentation tools.

6.3 APPLICATIONS

The developed system has a broad range of practical applications, including:

- **Educational Institutions**: Teachers and professors can deliver interactive lectures without needing to operate physical devices.
- **Corporate Presentations**: Business professionals can enhance meetings and presentations with seamless control.
- **Assistive Technology**: The system can be adapted for individuals with disabilities, providing an alternative means of controlling digital interfaces.
- **Live Streaming & Webinars**: Content creators can navigate slides and highlight key points during online presentations.

6.4 CONTRIBUTIONS

The innovative aspects of this project contribute to the field of **human-computer interaction (HCI)** by:

- Introducing an **AI-driven, vision-based** gesture control approach for slide navigation.
- Reducing dependency on **hardware-based presentation controllers**.
- Enhancing accessibility for users with mobility impairments.
- Laying the groundwork for **future gesture-controlled applications** in various domains.

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APPENDICES

Appendix A: Source Code

The following is the source code used for the **Gesture Master** project. This script implements real-time gesture control for interactive presentations using computer vision.

```
#importing libraries
from cvzone.HandTrackingModule import HandDetector
import cv2
import os
import numpy as np
import speech_recognition as sr

# Parameters
width, height = 1280, 520
gestureThreshold = 400
folderPath = ("ppp1")

# Camera Setup
cap = cv2.VideoCapture(0)
cap.set(3, width)
cap.set(4, height)

recognizer = sr.Recognizer()
detectorHand = HandDetector(detectionCon=0.8, maxHands=1)

# Variables
imgList = []
delay = 20
buttonPressed = False
counter = 0
drawMode = False
```

```
imgNumber = 0
delayCounter = 0
annotations = [[]]
annotationNumber = -1
annotationStart = False
hs, ws = int(120 * 1), int(213 * 1)   # width and height of small image

# Zoom Parameters
zoomScale = 1.0
zoomSpeed = 0.02

# Get list of presentation images
pathImages = sorted(os.listdir(folderPath), key=len)

# Function to draw on the image with a given color
def drawOnImage(img, indexFinger, color):
    cv2.circle(img, indexFinger, 15, color, cv2.FILLED)

while True:
    success, img = cap.read()
    img = cv2.flip(img, 1)
    pathFullImage = os.path.join(folderPath, pathImages[imgNumber])
    imgCurrent = cv2.imread(pathFullImage)
    imgCurrent = cv2.resize(imgCurrent, (width, height))

    hands, img = detectorHand.findHands(img)
    cv2.line(img, (0, gestureThreshold), (width, gestureThreshold), (0, 255, 0),
10)

    if hands and buttonPressed is False:
        hand = hands[0]
        cx, cy = hand["center"]
        lmList = hand["lmList"]
```

```
fingers = detectorHand.fingersUp(hand)

xVal = int(np.interp(lmList[8][0], [width // 2, width], [0, width]))
yVal = int(np.interp(lmList[8][1], [150, height-150], [0, height]))
indexFinger = xVal, yVal

if cy <= gestureThreshold:
    if fingers == [1, 0, 0, 0, 0]:  # Left
        buttonPressed = True
        if imgNumber > 0:
            imgNumber -= 1
            annotations = [[]]
            annotationNumber = -1
            annotationStart = False

    if fingers == [0, 0, 0, 0, 1]:  # Right
        buttonPressed = True
        if imgNumber < len(pathImages) - 1:
            imgNumber += 1
            annotations = [[]]
            annotationNumber = -1
            annotationStart = False

if fingers == [0, 1, 1, 0, 0]:  # Cursor Activate
    cv2.circle(imgCurrent, indexFinger, 12, (0, 0, 255), cv2.FILLED)

if fingers == [0, 1, 0, 0, 0]:  # Drawing
    if annotationStart is False:
        annotationStart = True
        annotationNumber += 1
        annotations.append([])
    annotations[annotationNumber].append(indexFinger)
    cv2.circle(imgCurrent, indexFinger, 12, (0, 0, 255), cv2.FILLED)
```

```
        if fingers == [0, 1, 1, 1, 0]:  # Undo the drawen content on the slide
            if annotations:
                annotations.pop(-1)
                annotationNumber -= 1
                buttonPressed = True

    if buttonPressed:
        counter += 1
        if counter > delay:
            counter = 0
            buttonPressed = False

    for annotation in annotations:
        for j in range(len(annotation) - 1):
            cv2.line(imgCurrent, annotation[j], annotation[j+1], (0, 0, 200), 12)

    imgCurrent = cv2.resize(imgCurrent, None, fx=zoomScale, fy=zoomScale)
    cv2.imshow("Slides", imgCurrent)

    key = cv2.waitKey(1)
    if key == ord('q'):
        break

cv2.destroyAllWindows()
```