IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

Gesture Controlled Air-Canvas

Prof Rajendra Arakh
Computer Science and Engineering Dept.
Shri Ram Institute of Technology
Jabalpur, India

Saatvik Pathak
Computer Science and Engineering Dept.
Shri Ram Institue of Technology
Jabalpur India

Sahitya Dubey
Computer Science and Engineering Dept.
Shri Ram Institute of Technology
Jabalpur, India

Ranvijay Singh
Computer Science and Engineering Dept.
Shri Ram Institute of Technology
Jabalpur, India

Yogesh Jharbade
Computer Science and Engineering Dept.
Shri Ram Institute of Technology
Jabalpur, India

Abstract*— Hand Artificial Intelligence has entered a whole new age thanks to gesture recognition. Technology known as gesture recognition translates hand gestures into commands. An inventive and dynamic digital Air-Canvas is the Gesture Controlled Virtual Air-Canvas Project. Using this Air-Canvas can help students overcome a variety of educational obstacles and learn in a creative and enjoyable way, revolutionizing the way traditional teaching is done. It can be challenging for elderly or physically disabled people to recognize and hit the correct keyboard key. The current technology only permits users to draw freely using three distinct colors. Our suggested system's ultimate purpose is to get over all of these obstacles. The motion sensing technique used by this system makes use of the Mediapipe library and the OpenCV module to explain results.

I. Introduction

Writing is essential to communication. Writing has been a fascinating voyage of growth. Prehistoric people first made rudimentary marks on cave walls. Later, they used keyboards and digital pens, and in the age of artificial intelligence, touchless writing emerged. A hand gesture is a nonverbal communication method in which the purposeful movement or arrangement of hands is used to express an idea or a feeling. These gestures can be as basic as waving or pointing, or they can be more intricate and culturally unique signals. Hand gestures are also used in technology for interactive purposes, allowing users to manipulate interfaces or gadgets using particular hand movements.

We developed a prototype model using these hand motions that can identify and execute various activities like free-style drawing, shape drawing, color selection, thickness adjustment, and gesture-controlled PowerPoint presentations. To improve human-computer interaction, this system was constructed with the Python programming language and includes a number of modules, including OpenCV and NumPy. mediapipe. Tools and functions for computer vision and image processing tasks are provided by the OpenCV (Open Source Computer Vision) library. With the least amount of latency, this artificial intelligence software will track the user's hand movements in real time and display the results on an Air-Canvas.

The significance of e-learning has grown significantly during the epidemic, therefore this gesture-controlled virtual Air-Canvas will offer engaging and practical online teaching strategies. Teachers find it challenging to explain concepts or draw something on the screen using the mouse and keyboard in online learning since it leads to a lot of mistakes. Teachers will no longer need to utilize such technology because this system allows them to easily write on the board and navigate with their fingertips in the air. This project will also construct an offline dustless classroom since calcium carbonated chalk is not required. This calcium carbonate leads to a number of respiratory issues, including sinus, allergy, and eye irritation. Markers made with plastic boards will also negatively impact the environment due to rising global temperatures. Since no special skills are needed to operate this system, gesture-controlled schooling will improve the interactive communication skills that older and special-needs individuals lack. Anyone, regardless of age, can utilize it to improve their communication skills. This technique can be helpful for PowerPoint presentations and can lessen the need for additional hardware, like a remote control PowerPoint presenter, which can be cumbersome on workspaces. The user and their workspace are considerably closer than before because it replaces the hardware gadgets. Thus, Gesture Controlled Virtual Air-Canvas offers engaging, captivating, dynamic, and up-to-date teaching techniques.

II. Literature Survey

The purpose of this study is to comprehend OpenCV's image processing capabilities. First, the webcam records the video frame by frame. Next, the user chooses a color from the header while the system simultaneously records the movements of their fingertips. The user can now finally draw, erase, and clean the board. There are no other brush sizes or colors available with this technique. [1]

The user in this system should be wearing finger beads of the same color as the program's initialization. To identify the coordinates provided to each fingertip, the user must activate the web camera. The screen shows the four colors along with their names. Everything is displayed on the screen and the user can write by simply waving their fingers. Using the clear all option, the user can wipe the screen. There could be issues if the user didn't use the same color bead that the program initialized. [2]

This system makes use of a Python software with a tKinter-created graphical user interface. Users can select colors and get information about a virtual canvas using the interface. The application records video using the OpenCV library and then transforms it into a predetermined color space. Buttons for changing the screen's color and clearing it show as the live video plays. In order to "write in the air," users must use the spacebar to allow the software to identify an item. Users can view the outcome on the screen when the application outlines an object after it has been identified. The 'esc' key can be used to exit the application. It's important to note that this method does not have a frame designed specifically for various shapes. [3]

The user of the suggested system can paint with their fingertips. The user can paint on the canvas with OpenCV, while hand tracking is done with Mediapipe. OpenCV is used for computer vision, and Mediapipe is used for hand movements and tracking. If the user's index finger is up, they can draw anything on the screen and choose a color from a color palette. The screen's position can be adjusted if all fingers are up. The clear option allows the user to clear the screen. Brush forms are not available in this system. [4]

In this project, for hand detection Mediapipe library is used for accuracy and functionality. The changes in position of index finger is tracked using Mediapipe. For selection of color both middle finger and index finger are used. User can select colors by hovering over desired color. For drawing, Users can create drawings by placing individual points at short time intervals, which collectively give the impression of a continuous line. The output is displayed on the white canvas. This project does not have different shapes, also user cannot adjust thickness of the letters. [5].

III. Methodology

1) *Setup*: To record the user's hand motions, purchase a camera or make use of one that already exists. Install and set up the required programs, such as the Mediapipe library.

2) *Identify & Extract Key Hand Landmarks*: To locate and identify the user's hand in the camera feed, use the Mediapipe library's hand tracking module. Determine the hand's important landmarks, including the location of the palm and fingertips.

3) *Identifying Motions*: Use the hand landmarks that have been identified to implement a gesture detection system and create distinct motions for tasks like navigating, drawing, and erasing. Use Media pipe's pre-trained models to achieve precise and effective recognition.

4) *Task assignment:* Utilize extra predefined movements to incorporate features for clearing the canvas, storing work, and other pertinent operations. Gestures can be used to convey a PowerPoint.

5) *Canvas Interaction*: The user can utilize hand gestures to accomplish actions as they see fit. This is accomplished by mapping the identified gestures to the appropriate virtual Air-Canvas activities, like erasing or drawing lines. Use the user's hand movements to update the virtual Air-Canvas in real time. Provide an intuitive user interface that shows the virtual canvas so that users may communicate with the system.

6) *Testing:* To guarantee precise and responsive gesture recognition, carry out a thorough testing process.

The two primary stages of hand gesture identification are palm detection and hand landmarks.

a) *Palm Detection*: The main objective of palm detection is to determine whether and where a hand is present in the input. The module uses a machine learning model that has been trained to identify the general shape and look of a human hand for this purpose. Based on patterns it has learnt, it scans the input frames and pinpoints regions that most likely contain a hand. The technology gives details about the bounding box or area surrounding the identified palm as soon as a hand is detected. This data forms the basis for additional hand gesture analysis.

b) *Hand Landmarks*: These entails pinpointing particular locations or landmarks on the detected hand in order to provide a thorough tracking of its orientation and motion. Following palm detection, the module examines the hand in more detail by locating important landmarks including the base of the hand, the tips of the fingers, and locations along the palm's contours.

IV. Proposed System

The suggested Gesture Controlled Virtual Air-Canvas, which offers a more effective and user-friendly interface than the existing system, is a major improvement. The limited creative functionality of the current system is blatant evidence of its limits. Users are restricted to a small color palette, usually consisting of no more than three or four colors for drawing. Furthermore, the system doesn't allow users to customize line widths to suit their preferences; instead, it enforces a constant thickness when drawing shapes.

Moreover, the lack of a save feature limits users' ability to store their work for later use. By fixing these flaws in the suggested Gesture Controlled Virtual Air-Canvas, the user experience is improved and a more feature-rich and adaptable platform for presentation and creative expression is provided. After engaging with the system, users are automatically redirected to the Air-Canvas interface, where they can utilize hand gestures to express their creativity. The Mediapipe library is used for hand gesture detection in the implementation, while the OpenCV Python library is used to initialize the camera.

The main role is to record video frames from the webcam and use the Mediapipe library to transform them from BGR to RGB for effective hand detection. This allows users to interact with a virtual paint software in which the hand gestures are identified by analyzing each frame. By using Mediapipe to retrieve the tip IDs and matching finger coordinates, the system is able to correctly calculate the precise finger positions and execute commands in accordance with the collected data.

Additionally, the same module is used in a PowerPoint presenter function that lets users present presentations with hand gestures and browse slides easily. The fingers are interpreted by the system, which then performs certain actions according on its interpretation. This gives the system a useful component in addition to streamlining the creative process in the virtual art area.

A. Libraries Used

1) Mediapipe

Google created Mediapipe, a flexible computer vision framework that makes it easier to create real-time applications combining machine learning and perceptual computing. For applications including object identification, pose estimation, facial recognition, and hand tracking, it provides a modular architecture. One noteworthy aspect is its capacity for quickly processing and interpreting image sequences or video streams, which makes it appropriate for a variety of applications such as augmented reality and virtual interfaces. Mediapipe's intuitive architecture makes it easier to incorporate cutting-edge computer vision capabilities into a variety of projects, giving developers a strong toolkit for building intelligent and engaging apps.

2) OpenCV

The OpenCV (Open Source Computer Vision) Library is a feature-rich image processing library created to offer a strong toolkit for creating computer vision, machine learning, and artificial intelligence applications. Numerous features are covered by the library, such as object identification, face recognition, feature extraction, picture and video processing, and machine learning methods. OpenCV is adaptable for applications on desktop, mobile, and embedded devices since it supports a variety of platforms. Its large library of pre-built functions and algorithms makes difficult tasks like camera calibration, edge recognition, and image stitching simple.

3) NumPy

One essential Python library for numerical computing is called NumPy, or Numerical Python. Large arrays and matrices are supported by this robust tool, which makes it useful for a variety of mathematical tasks. A collection of high-level functions called NumPy make working with these arrays easier and increase the accessibility of tasks like general math, statistics, and linear algebra. Numerical calculations are performed at a faster rate thanks to its effectiveness in managing broadcasting and array operations. NumPy is the basis for several other scientific libraries written in Python, demonstrating its central place in the ecosystem. NumPy is essentially an essential part of Python applications for effective data processing and numerical activities.

V. Some New Features

MultiHands

In the domain of gesture-based drawing interfaces, the incorporation of multi-hand functionality is paramount for enhancing user interaction and expanding the scope of creative expression. MultiHands feature enables the Air Canvas system to detect and track the positions of multiple hands simultaneously, allowing for collaborative drawing experiences and more intricate gestures.

1) Implementation

The MultiHands feature in Air Canvas leverages advanced machine learning techniques and computer vision algorithms to detect and track the landmarks of multiple hands in real-time. We employ Google's MediaPipe library, specifically the Hands module, to achieve robust hand landmark detection.

2) Technical Details

1. **Enhanced Hand Detection:** The MultiHands feature extends the capabilities of Air Canvas to detect and track multiple hands concurrently. This is achieved through optimized configurations of the MediaPipe Hands module, enabling the system to handle complex hand interactions seamlessly.

2. **Multi-Hand Landmark Tracking:** Upon detecting multiple hands in the frame, the system processes each hand independently to extract its landmarks. These landmarks, including key points such as fingertips and palm centers, are then tracked in real-time to enable gesture recognition and drawing functionalities.

3. **Collaborative Drawing:** With the MultiHands feature, users can engage in collaborative drawing sessions, where multiple participants can contribute to the canvas simultaneously using their respective hands. This opens up new possibilities for cooperative artistic endeavors and interactive experiences.

4. **Gesture Diversity:** The presence of multiple hands enriches the range of possible gestures recognized by Air Canvas. Users can perform intricate hand movements, such as hand gestures representing shapes or symbols, which are accurately interpreted and translated into drawing

3D Drawing

The integration of a 3D drawing feature represents a groundbreaking advancement in the Air Canvas system, elevating the platform beyond traditional 2D drawing interfaces. By incorporating three-dimensional drawing capabilities, Air Canvas offers users a unique and immersive creative experience, enabling them to express their ideas in a spatially rich environment.

3) Implementation

The 3D drawing feature in Air Canvas is realized through a combination of machine learning techniques, computer vision algorithms, and rendering technologies. Leveraging cutting-edge advancements in these fields, the system empowers users to create and manipulate three-dimensional shapes and structures with intuitive hand gestures.

4) *Technical Details*

1. **Hand Gesture Recognition:** The 3D drawing feature utilizes hand gesture recognition algorithms to interpret users' movements and gestures in three-dimensional space. By analyzing the positions and trajectories of the user's hands, the system accurately interprets gestures such as pointing, grabbing, and shaping.

2. **Spatial Mapping:** Air Canvas employs spatial mapping techniques to create a virtual three-dimensional canvas within which users can draw and manipulate objects. By mapping the physical space surrounding the user and tracking the positions of their hands within this space, the system establishes a spatial context for drawing operations.

3. **Rendering Engine:** To visualize the drawn objects in three dimensions, Air Canvas utilizes a powerful rendering engine capable of rendering complex 3D geometry in real-time. This engine leverages hardware acceleration and optimized rendering techniques to ensure smooth and responsive visualization of the user's creations.

4. **Interaction Paradigms:** The 3D drawing feature introduces novel interaction paradigms that enable users to interact with the virtual canvas in intuitive and natural ways. For example, users can use hand gestures to sculpt, rotate, scale, and move objects within the 3D space, providing a fluid and immersive drawing experience.

VI. CONCLUSION

As part of this research project, we have created a Gesture Controlled Virtual Air-Canvas that enables users to perform tasks using hand gestures in midair, such as drawing, erasing, and presenting PowerPoint presentations. The execution entails the using the Mediapipe library to detect hand gestures, which obviates the requirement for conventional image processing methods and permits real-time tracking of hand movements. With the technology, users may engage with a virtual canvas through simple hand gestures, enabling tasks like painting and erasing without the use of tangible instruments. Furthermore, the user can move through a PowerPoint presentation by using particular hand gestures. Real-time, accurate, and responsive hand gesture recognition is ensured by using this method. The effectiveness of this project's screen management is one of its main advantages. The user experience is improved by the ease with which users can save their work and clear the entire virtual canvas with a few quick hand gestures. In addition to its useful uses, this project brings a fresh and interesting method of instruction by using technology that encourages innovation and ease of use in the learning process.

VII. REFERENCE

[1] Ramachandra H.V. , Balaraju G, Deepika K, Navya M.S, "Virtual Air Canvas Using OpenCV and Mediapipe" in 2022 International Conference on Futuristic Technologies (INCOFT).

[2] B Anand Kumar,T Vinod,M srinivas Rao, "Interaction through Computer Vision Air Canvas" in 2022 International Conference on Advancements in Smart, Secure and Intelligent Computing (ASSIC).

[3] Palak Rai, Reeya Gupta,Vinicia Dsouza,Dipti Jadhav, "Virtual canvas for interactive learning using OpenCV" in 2022 IEEE 3rd Global Conference for Advancement in Technology (GCAT).

[4] Nenavath Rahul , A Snigdha , K. Jeffery Moses , S.Vishal Simha, "Painting with Hand Gestures using MediaPipe" in 2022 International Journal of Innovative Science and Research Technology.

[5] Shaurya Gulati, Ashish Kumar Rastogi, Mayank Virmani, Rahul Jana, Raghav Pradhan, Chetan Gupta "Paint / Writing Application through WebCam using MediaPipe and OpenCV" in 2022 2nd International Conference on Innovative Practices in Technology and Management (ICIPTM) .

[6] Koushik Roy, Md. Akiful Hoque Akif "Real Time Hand Gesture Based User Friendly Human Computer Interaction System" in 2022 3rd Int. Conf. on Innovations in Science, Engineering and Technology (ICISET) 26-27 February 2022.

[7] K Sai Sumanth Reddy, Abhishek R , Abhinandan HeggdeLakshmi Prashanth Reddy "Virtual Air Canvas Application using OpenCV and Numpy in Python" in IJARIIE Vol-8 Issue-4 2022.

[8] Dr. B. Esther Sunanda, M. Bhargavi, , M. Tulasi Sree, M.R.S. Ananya, N. Kavya "AIR CANVAS USING OPENCV, MEDIAPIPE" in International Research Journal of Modernization in Engineering Technology and Science Volume:04/Issue:05/May-2022.

[9] Kavana KM, Suma NR "RECOGNIZATION OF HAND GESTURES USING MEDIAPIPE HANDS" in International Research Journal of Modernization in Engineering Technology and Science under Volume:04/Issue:06/June-2022.

[10] I. J. Tupal and M. Cabatuan, "Vision-Based Hand Tracking System Development for Non-Face-to-Face Interaction," 2021 IEEE 13th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM), Manila, Philippines, 2021.

[11] Cheng Ming, Yan Yunbing "Perception-Free Calibration of Eye Opening and Closing Threshold for Driver Fatigue Monitoring" in the National Natural Science Foundation of China under Grant 51975428 and Grant 52002298.

[12] Y. Quiñonez, C. Lizarraga and R. Aguayo, "Machine Learning solutions with MediaPipe," 2022 11th International Conference On Software Process Improvement (CIMPS), Acapulco, Guerrero, Mexico, 2022.

[13] Subhangi Adhikary, Anjan Kumar Talukdar,

Kandarpa Kumar Sarma "A vision-based system for recognition of words used in indian sign language using mediapipe" in 2021 Sixth International Conference on Image Information Processing (ICIIP).

[14] Rafiqul Zaman Khan and Noor Ibraheem, "Hand Gesture Recognition: A Literature Review", August 2012, International Journal of Artificial Intelligence & Applications.

[15]

[16] Alper Yilmaz, Omar Javed, Mubarak Shah, "Object Tracking: A Survey", ACM Computer Survey. Vol. 38, Issue. 4, Article 13.

Jeong-Seop Han, Choong-Iyeol Lee, Young-Hwa Youn, Sung-Jun Kim,"A Study on Real-time Hand Gesture Recognition Technology by Machine Learning- based MediaPipe" in Journal of System and Management Sciences, 2022.