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Virtual Air Canvas

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ABSTRACT

The Virtual Air Canvas project offers an innovative approach to digital drawing by leveraging hand gesture recognition for a touch-free, cost-effective, and user-friendly experience. Unlike traditional systems that depend on specialized hardware or touchscreen devices, this system uses computer vision to interpret hand movements, allowing users to draw in the air effortlessly. The application supports basic drawing features, including color selection and stroke adjustment, and introduces enhanced precision by detecting when fingers close to pause drawing.

Designed with Streamlit, this project focuses on addressing existing limitations like imprecision, high costs, and restricted functionality. By combining gesture recognition, user-centric design, and real-time responsiveness, Virtual Air Canvas aims to bridge the gap between traditional and digital artistry, providing a versatile tool for artists, educators, and creative enthusiasts.

1-INTRODUCTION

Writing has evolved majorly over the years. They first started writing on walls then it was replaced by stones. Stones were replaced by cloth and presently we use paper for communication. With the help of QWERTY keyboards, we are moving towards a more digitalized form of writing. These electronic devices are slowly taking the place of traditional forms of writing with pen and paper. The need to develop human machine interactions is rapidly growing with the surge in the usage of augmented and virtual reality.

The Virtual Air Canvas is a fascinating project that brings together the world of art and computer vision. The initial motivation idea was a need for a dustless and clean class room for the students to study with a peaceful mind. We know that there are several ways like touch screens and more electronic gadgets, but what about the schools which can't afford it to buy such huge large electronic gadgets and teach on them like a T.V or one screen.

So, we thought why not can a finger be tracked. Hence it was OpenCV which came to the rescue for these computer vision projects. We know that artists create paintings on a canvas. But what if we can paint on air just by waving our hands. So, in this project, we are going to build an air canvas using OpenCV and Python.

Existing system

The most common way of digital drawing is to use a digital tablet where a contact point between a tool and the surface of the tablet can be tracked. In general, digital tablets are provided with a stylus rigid tool tip or sometimes support the tracking of bendable or flexible bristles for better feedback.

Proposed System

In this computer vision project that is an Air Canvas which helps to draw on a screen just by waving your finger fitted with a colorful point or a simple colored cap. It was OpenCV which came to the rescue for these computer vision projects. The proposed method provides a natural human-system interaction in such way that it does not require keypad, stylus, pen or glove etc for character input. This computer vision experiment uses an Air canvas, which allows you to draw on a screen by waving a finger equipped with a colourful tip. These computer vision projects would not have been possible without OpenCV's

help. There are no keypads, styluses, pens, or gloves needed for character input in the suggested technique.

2-REQUIREMENT ANALYSIS

Functional Requirements

The **functional requirements** of the virtual air canvas for the **User Module** focus on providing an intuitive and seamless experience for users. The system should offer a user-friendly interface that allows individuals to interact with the virtual canvas using gestures or compatible input devices.

Modules

User Module

Register and log in to the system

Draw on the virtual canvas using hand gestures

Logout of the system

Non-Functional Requirements

The non-functional requirements of a Virtual Air Canvas include real-time gesture processing, smooth rendering, platform compatibility, and robust security. The system should be user-friendly, reliable, and scalable, with modular design for easy maintenance.

Performance

The system must detect gestures and update drawings in real-time with a maximum latency of 50-100ms to ensure smooth operation.

Usability

It should feature an intuitive interface with clear feedback to make it accessible for users with minimal technical expertise.

Hardware Requirements

Processor : Intel Core i5

Ram : 8GB.

SSD : 256 GB

Software Requirements:

Operating System : Window 10

Front end technologies : Streamlit

Coding Language : Python

IDE : PyCharm

Library: OpenCV

3. DESIGN

Software Architecture:

The software architecture for a Virtual Air Canvas is designed using a client-server model with modular components to ensure scalability and maintainability. The user module plays a vital role in managing user interactions, starting with registration and login, where user credentials are securely stored and authenticated using encryption and token-based systems. Once logged in, the system initializes the canvas by loading user preferences and settings. The gesture-based drawing feature processes input from a webcam using gesture recognition algorithms like OpenCV or Streamlit, enabling real-time drawing on the canvas. Users can select tools and colors dynamically, with changes reflected instantly on the canvas. Drawings can be saved locally or uploaded to cloud storage using services like AWS S3 or Firebase. The logout functionality ensures a secure end to the session by clearing session data or invalidating authentication tokens. This architecture incorporates a user-friendly frontend, powered by frameworks like Streamlit, and a robust backend developed with Python, supported by databases such as MySQL for managing user data and saved drawings efficiently.

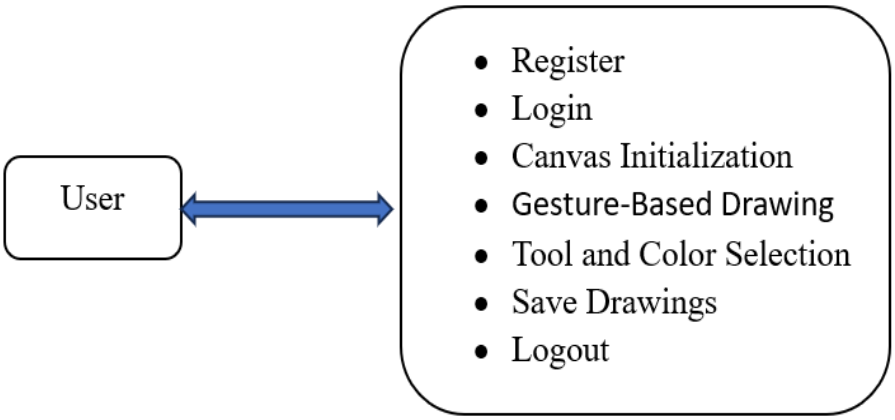


Fig. 3.1 Software Architecture

Technical Architecture

The technical architecture of the Virtual Air Canvas is designed to ensure seamless communication between the frontend and backend, providing an interactive user experience. The frontend is built using Streamlit, HTML5, and CSS3, forming the user interaction layer. Streamlit is utilized for creating an interactive web application that simplifies deploying machine learning models and gesture recognition systems. HTML5 enables the rendering of the drawing canvas and captures real-time gesture inputs through media APIs like <canvas>. CSS3 is used to style the interface, ensuring a visually appealing and intuitive design. The backend, developed in Python, serves as the processing engine. It leverages libraries such as OpenCV or TensorFlow for gesture recognition, translating user gestures into drawing actions on the canvas. Python also manages tool selections, color changes, and saving drawings, ensuring efficient handling of user requests. The communication between the frontend and backend is handled in real-time, where user inputs are streamed from the frontend to the backend for processing and the updated canvas state is sent back to the frontend for rendering. This architecture ensures a lightweight, responsive, and user-friendly platform for gesture-based drawing.

4-IMPLEMENTATION

Technologies:

This System is developed using python programming language in PyCharm IDE.

Python

Python is one of the most popular programming languages now existing. The main reason for the creation of a programming language like python was to enhance the features to a large extent that were available in the present existing languages. The other reason was to invent a language which can be used easily for the developers who work a lot on media other than texts like speech, images and videos. In SignConnect, Python is used to load and preprocess images by resizing, normalizing, and applying data augmentation techniques to improve model robustness. You then define a Convolutional Neural Network (CNN) using TensorFlow or Keras, consisting of layers such as Conv2D, MaxPooling2D, Flatten, Dense, and Softmax for classification. The model is trained on the prepared dataset, and its performance is evaluated using accuracy metrics. Once trained, the model can make predictions on new images by preprocessing them

and passing them through the network. For real-time predictions,

OpenCV is used to capture webcam images, preprocess them, and perform classification. Lastly, the model can be deployed as a web service using Flask or Django, or as a mobile app with TensorFlow Lite.

5-TESTING

Software testing is a process, to evaluate the functionality of a software application with an intent to find whether the developed software met the specified requirements or not and to identify the defects to ensure that the product is defect free in order to produce the quality product. As per the current trend, due to constant change and development in digitization, our lives are improving in all areas. The way we work is also changed. We access our bank online, we do shop online; we order food online and many more. We rely on software's and systems. What if these systems turnout to be defective? We all know that one small bug shows huge impact on business in terms of financial loss and goodwill. To deliver a quality product, we need to have Software Testing in the Software Development Process. Some of the reasons why software testing becomes very significant and integral part in the field of information technology are as follows.

1. Cost effectiveness
2. Customer Satisfaction
3. Security
4. Product Qualit

Dimensions of Testing

There are many different dimensions to consider:

Layers of the application (database, APIs, UI)

Scale of testing (unit, module, integration, scenario)

Type of testing (functional, performance, security, etc.)

Methodology (exploratory, scripted manual, automated)

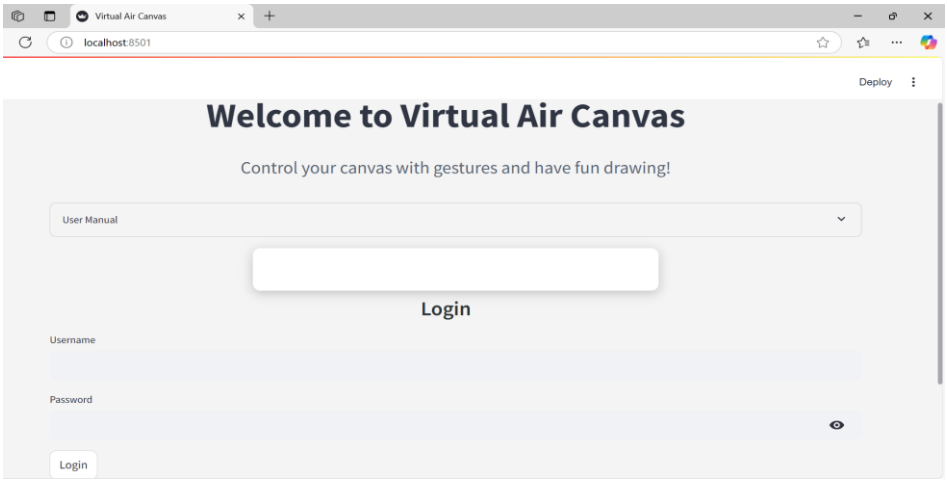
Unit Testing

During This first round of testing, the program is submitted to assessments that focus on specific units or components of the software to determine whether each one is fully functional.In this phase, a unit can refer to a function, individual program or even a procedure, and White box testing method is usually used to get the job done. One of the biggest benefits of this testing phase is that it can be run every time a piece of code is changed, allowing issues to be resolved as quickly as possible. It quite common for software developers to perform unit tests before delivering software to testers for formal testing.

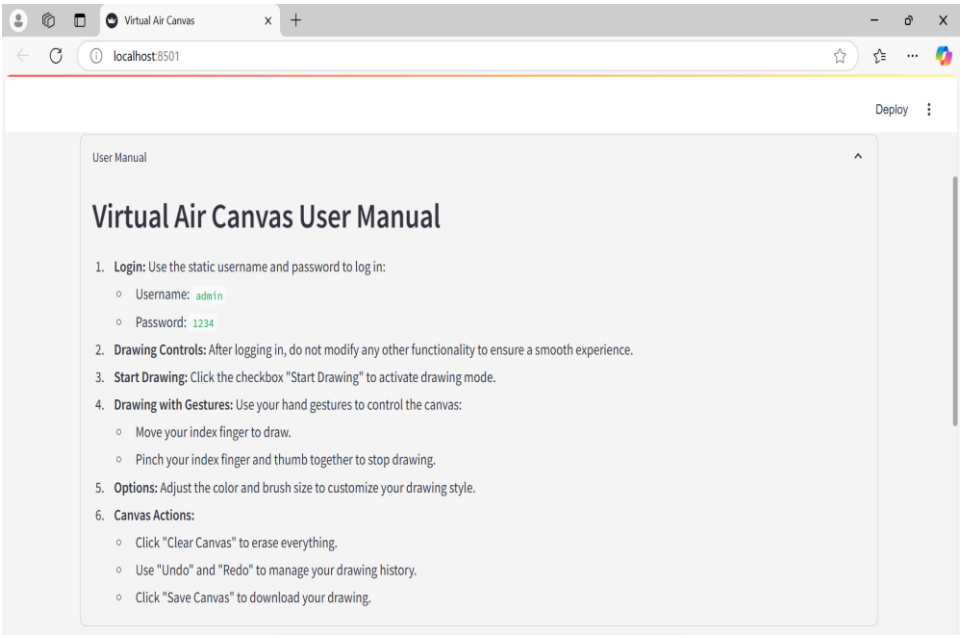
System Testing

System testing is the first level in which the complete application is tested as a whole. The goal at this level is to evaluate whether the system has complied with all of the outlined requirements and to see that it meets Quality Standards. System testing is undertaken by independent testers who haven't played a role in developing the program. This testing is performed in an environment that closely mirrors production. System Testing is very important because it verifies that the application meets the technical, functional, and business requirements that were set by the customer.

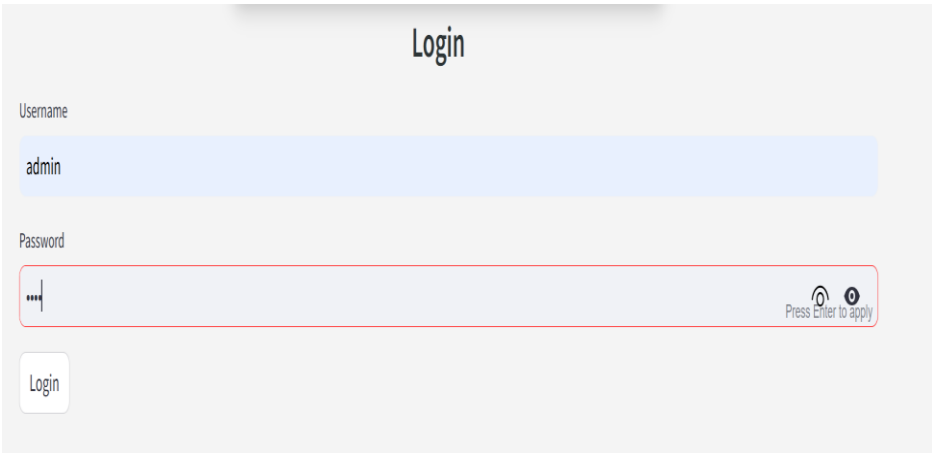
6-SCREENSHOTS



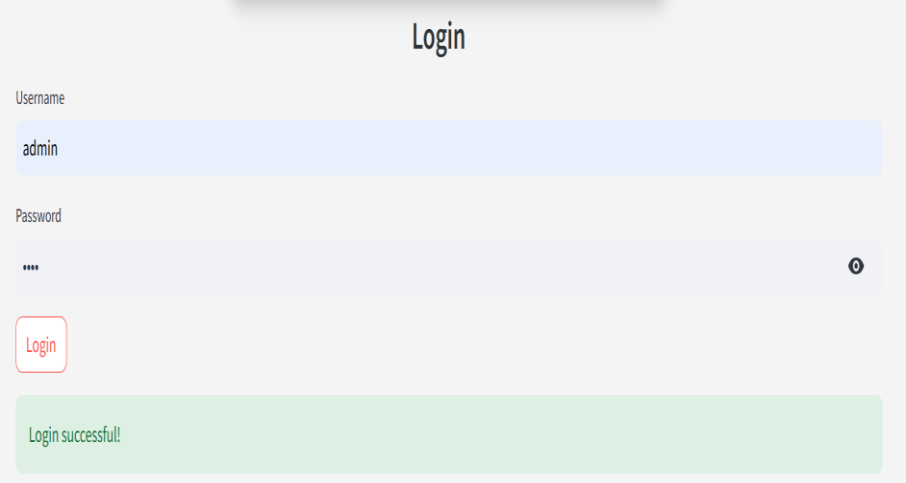
Screenshot 6.1 Application Landing Page



Screenshot 6.2 User Manual

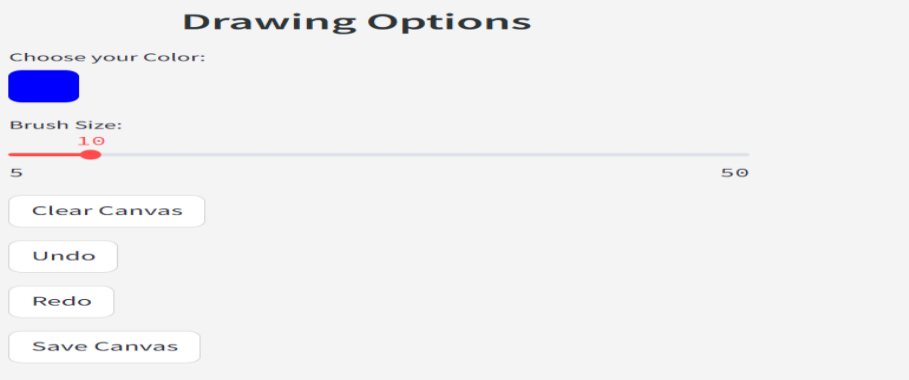


Screenshot 6.3 User Authentication Process

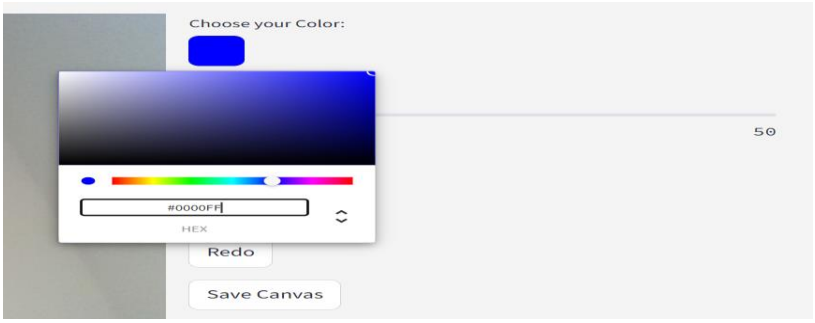


Screenshot 6.4 User Authentication Process

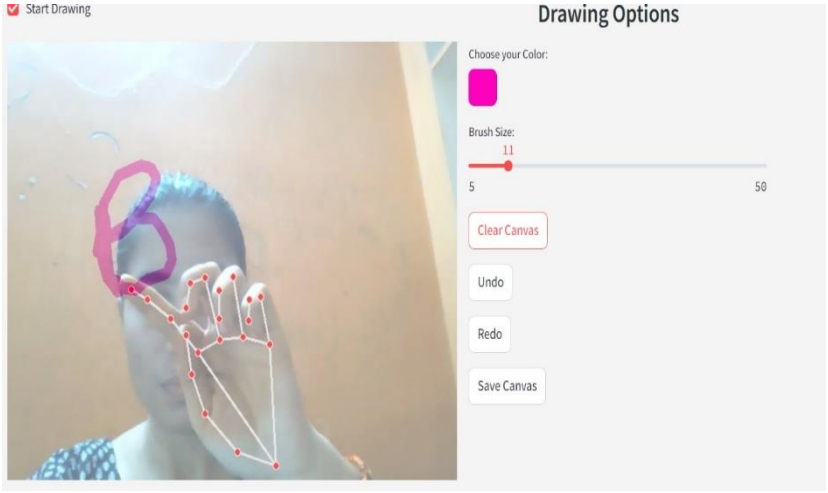
Screenshot 6.5 User Authentication Process



Screenshot 6.6 Drawing Options



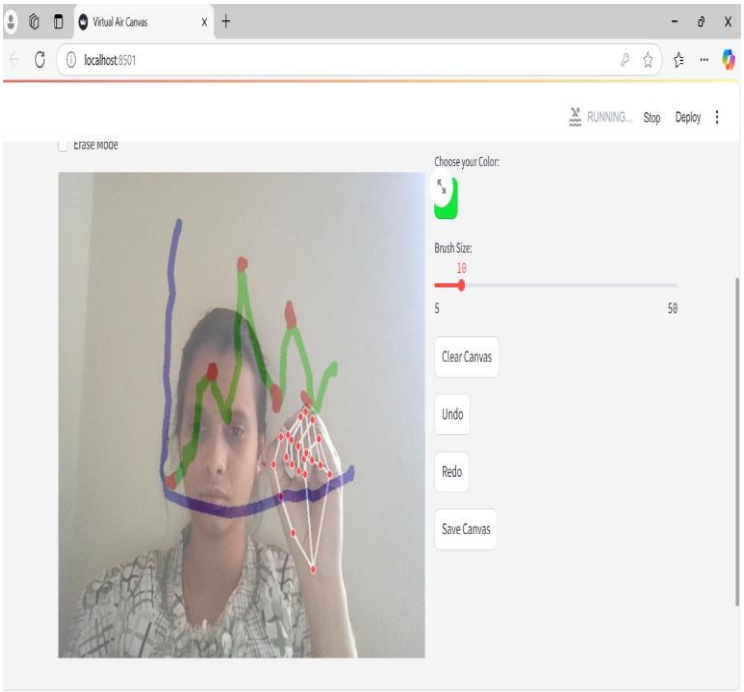
Screenshot 6.7 Drawing Options



Screenshot 6.8 Drawing in Action

Clear Canvas

Before



Screenshot 6.9 Clear canvas

After

7-CONCLUSION & FUTURE SCOPE

Conclusion

The Virtual Air Canvas is a game-changing tool that enables users to draw in the air using just their fingers, merging innovation with creativity. It simplifies artistic expression, making it not only accessible to individuals who face challenges with traditional input methods like keyboards but also an engaging medium for everyone. This technology promotes clear, inclusive, and dynamic communication, opening new avenues in education, entertainment, and professional design. As we step into an era of seamless human-computer interaction, tools like the Virtual Air Canvas will shape a future where creativity knows no bounds, empowering individuals to express themselves effortlessly and authentically.

Future Scope

Multiplayer Interaction: Allow multiple users to interact on the same canvas.

AI-powered Features: Predictive drawing or auto-correction for smoother output.

Extended Use Cases: Integration with AR/VR for immersive experiences.

Gesture Customization: Allow users to define their own gestures for different actions.

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