A Canvas of Air and Signs: Integrating Voice Activated Hand Sign Recognition and Air Canvas for Hearing Impaired and Non-Verbal People

Pratham Kumar[1]; Rishav Sharma[2]; Shruti[3]; Jaya Shree[4]; Virat Tiwari[5]; Varun Mishra[6]; Soumya Upadhyay[7]

[12345]Student, Department of Information Technology, College of Engineering Roorkee, Uttarakhand, India

[6,7]Faculty, Department of Information Technology, College of Engineering Roorkee, Uttarakhand, India

Abstract:- Moving hands in air and watching your screen writes for you and at the same time making different Signs with hands and the system displays it as well as speak what Sign you are making.This seems to be very futuristic approach towards the realm of Image Processing and Gesture Recognition . In this paper, we present a very interesting and a novel approach towards an interactive learning platform where one can draw the content on screen while moving their hand in air and can also use hand sign language to communicate with an ease with the Hearing Impaired and Dumb Community. Our system combines both technologies to create a smooth and engaging experience for users. It can be used in interactive art setups or virtual reality setups. Air canvas enables users to draw and manipulate digital content in mid-air with object tracking using Computer Vision and Mediapipe framework, while hand gesture recognition allows for real-time interpretation of Hand Signs to perform actions or commands within the system. This Model not only recognizes the sign but also speaks it loud using pyttsx3 a text-to-speech conversion Library, ensuring a good communication between a normal human and people with Non-Verbal and Hearing Impaired disability. To enhance the performance of the model We validate the model with a real dataset trained by us. This training was essential for refining the accuracy and efficiency of the model.

Keywords:- Air Canvas, Image Processing, Gesture Recognition, Real-Time, Virtual Reality, Computer Vision, Mediapipe, Pyttsx3, Dataset.

I. INTRODUCTION

In recent years, advances in interactive technologies have revolutionized the way humans interact with computers and digital content. Among these technologies, Air Canvas and Hand Gesture Recognition gives a new way to humans to get themselves engaged in such an interactive and intuitive user interface. Air canvas system enables to draw, sketch and manipulate the digital content by only just waving their hands in the air. This system eliminates the use of styluses or any other tablets and hardware devices. This system has an outstanding integration of hand gesture recognition with air canvas that enables computers to interpret and respond to gestures made by the user's hands, opening up new possibilities for natural and intuitive interaction. The feature of hand gesture recognition will surely be a great help to the Hearing Impaired and Non-Verbal community. Hand gesture recognition can be integrated into communication devices, such as smartphones, to provide Hearing Impaired individuals with alternative means of communication.

➢ *Computer Vision*

Computer vision is a technology or a field of Artificial Intelligence that enables Machines to Look through the World as the humans do by enabling the computer to identify the objects and humans through images and videos. Its basic functionality covers Acquiring an image , Processing the image , understanding the image.

➢ *MediaPipe*

MediaPipe is an open source framework which is used for making perception pipelines to perform time series data like images , videos, etc. It was developed by google for real time analysis of videos and audio on Youtube. Mediapipe Provides a strong Toolkit for building applications related to face detection , hand tracking , etc and more.

➢ *Gesture Recognition*

Gesture Recognition is a field of research in Computer Science and Technology that tries to detect or recognize and interpret Gestures made by Humans with the use of Machine learning mathematical Algorithms. These gestures can be made with hands , fingers , face , etc.The main objective of gesture recognition is to avoid the use of traditional input devices like mouse , keyboard , etc.

➢ *Pyttsx3*

Pyttsx3 is a Text-to-Speech library in python makes your program to speak text Aloud. With Pyttsx3 you can easily convert text into voice in your Python Projects . This makes it a useful tool for creating applications that requires voice activated / enabled outputs like voice assistant , etc.

II. LITERATURE REVIEW

As many researches have been carried out on both Air canvas and Hand Sign Detection and both of them have their significance in their fields seperately. But none of researches have ever been made out which shows the integration of the same. Some researches that have been carried out before on both the areas are mentioned below .

Air Canvas : Draw in Air by Sayli More , Prachi Mhatre,Shruti Pakhare, Surekha Khot [1] in which they developed a canvas for communicating a concept or presenting an idea in real world space.With air canvas, they accomplished a sans hand drawing that utilises open cv to recognise the client's point finger. By doing so,lines can be drawn any place the clients want.By using color tracking,contour detection, algorithmic optimization ,trackbars modules for the proposed system.

Air Canvas through Object Detection using open cv in python by Harshit Rajput,Mudit Sharma,Twesha Mehrotra,Tanya Maurya[2] which enables users to draw in mid air using a stylus on a virtual canvas.The System incorporates Object Detection techniques in OpenCV to track the stylus's position and real time drawing .They trained a Haar cascade classifier to detect the marker in the video stream.When the marker is detected,they used it's position to track the stylus and update the canvas in real time.

Air Canvas by Aniket Sandbhor , Prasad Rane , prathamesh Shirole , Pawan Phapale[3] in which they utilised camera and the screen for reading inputs and displaying outputs.They used their hand fingers to draw required shapes on the screen. To challenge the potential of traditional writing methods .It is very well carried out by using python libraries named as OpenCV and Mediapipe which are ready to used ML solutions for recognition and tracking.

Real-Time Sign Language Recognition System For Deaf And Dumb People by Furkan , Ms. Nidhi Sengar [4] in which the research proposes a system that utilizes algorithms for an application which helps in recognizing the various Indian signs named as Indian Real Time Sign Language.The system worked on 9 classes which came out to be 95% accurate with their images captured on every possible angle and tested on 45 different types of output. Image Acquisition, Feature Extraction, Orientation Detection and Gesture Recognition were the four major algorithms the proposed system consisted.

Hand Gesture Recognition and Voice Conversion for Deaf and Dumb by R.Anusha , K.Dhanalakshmi , S. Shravanthi , G. Hymanjali, T. Hemalatha [5] have propose a system in which they proposed a novel Convolutional neural network (CNN) using multi-channels of video streams , including colour information , depth clue , and body joints positions are used as input to the CNN in order to make it happened. They converted the identified gesture's text to speech .

Hand Gesture Recognition for Deaf and Dumb People by Mahesh Kumar.D [6] have proposed a system for identifying signing languages that is based on American Sign Language . The datasets they used consist of 2000 images of American Sign motions , in which 1600 were used for training and 400 for Validating . The dataset divided into 80:20 proportion , 80 for training and 20 for Validating. A CNN model is utilized to forecast hand motions. They used HSV (Hue, Saturation , Value) Method for recognising Backgrounds from the images. Segmentation , Morphological

techniques , and an Elliptical Kernal is subjected in the series of events for further procedures.

III. METHODOLOGY

Our integrated system primarily focuses on implementing air canvas and hand gesture recognition applications doesn't involve complex algorithms, it utilizes various techniques.

➢ *Open CV –*
OpenCV (Open-Source Computer Vision Library) is an open-source computer vision and machine learning software library**,** It helps in achieving functionalities such as image and video analysis, object detection and tracking, facial recognition and machine learning algorithms. We have used it in our system to capture the real time video frames as we have to capture the hand's movement for both our features.

➢ *Hand Landmark Detection –*
Media Pipe is an open- source framework developed by Google for building cross-platform multimodal perception pipelines. It is used for the following.

• *Hand Landmark Detection:*
Media Pipe is employed in our project to detect and localize key points i.e. landmarks on the user's hand in real-time. This landmark detection helps us to track the position of the hand and fingers of the user for both gesture recognition and for drawing control based on finger position.

• *Real Time Performance:*
The efficient implementation of Media Pipe enables users to experience the real time hand landmark detection and tracking providing a smooth and responsive experience without significant delays.

➢ *Colour Management –*
Numerical Python is a python library that supports multi-dimensional arrays and matrices. It helps in performing wide range of mathematical functions that includes arithmetic operations, trigonometric functions, exponential and logarithmic functions, etc.

➢ *We had Utilized NumPy Majorly in Air Canvas Application for the Following Parameters:*

• *Drawing Operations:*
NumPy is used to update the array with the corresponding pixel values to reflect the drawn strokes.

• *Colour Management:*
NumPy is used to facilitate colour management. It allows us to manipulate the colours.

➢ *Drawing Management –*

• *Deque-based Stroke Storage:*
Deques (double-ended queues) is a data structure that is used to store the drawing strokes as a sequence of points. It

allows to add and remove the points, enabling the smooth experience.

The Flowchart depicted in (**Fig.1**) show the comprehensive view of the working of various algorithms and commands togertherly which lead us to the perfect working of Air Canvas . This diagram meticulously outlines the sequential workflow and the interdependencies of each process, highlighting precision with which they are orchestrated to achieve the desired outcome.
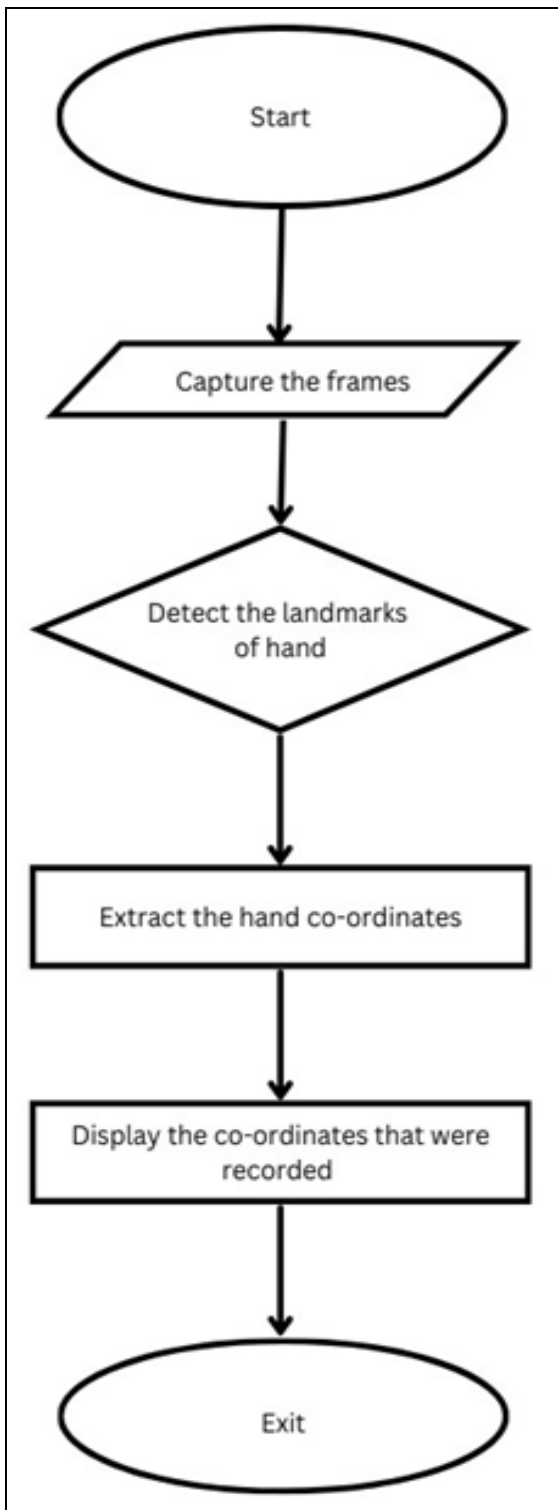

Fig 1 Flowchart of Air Canvas

➤ *Gesture Classification* –
Machine Learning Models: Hand gesture recognition involves training machine learning models on labelled gesture data. These models learn to recognize specific gestures based on the positions and movements of hand landmarks.

➤ *Classification Algorithms* –
Classification Models: Various classification algorithms, including deep learning models such as CNN, are employed to classify the hand gestures made by the user.

➤ *Custom Dataset* –
As our project has two integrated parts namely air canvas and hand gesture recognition, the air canvas doesn't require any dataset as it do not involve any machine learning techniques. Dataset used for hand gesture recognition was made by ourselves only.

➤ *Text to Audio : Pyttsx3* –
Our Hand gesture recognition system has a very helpful feature that generate the recognized result as an audio.
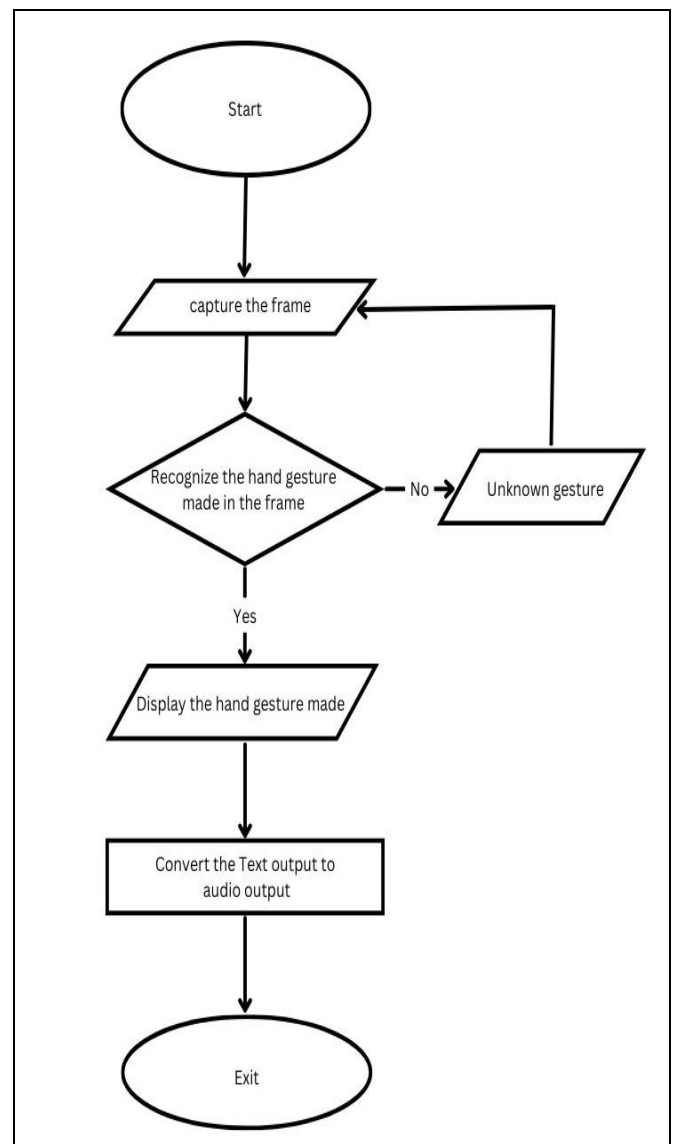

Fig 2 Flowchart of Hand Sign Detection

The Flowchart depicted in (**Fig.2**) show the comprehensive view of the working of various algorithms and commands togertherly which lead us to the perfect working of Air Canvas.

IV. RESULT

The frame capturing process is matched with the movement of the object onto the canvas.Thus,the system is able to analyse the live video frames of the real time and presenting the object movements on the canvas and creating an interactive user experience.We can use the same object detection techniques to detect the marker.When the position of the marker is detected it can be used for detecting the position of the pattern that we are making on the canvas and update the virtual canvas in the live feed. (**Fig. 3**)
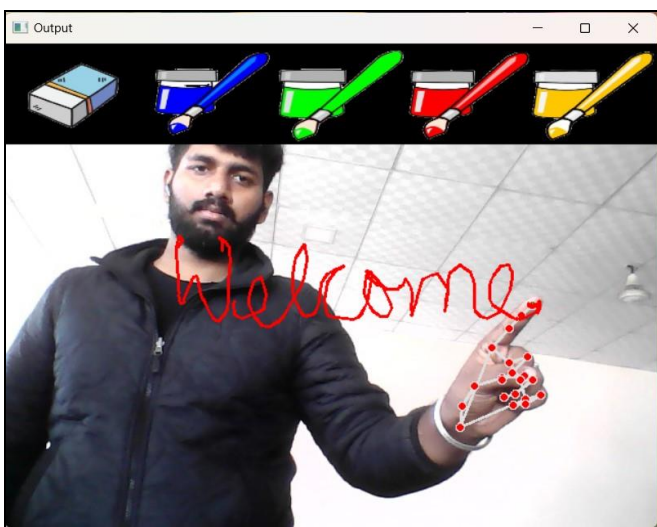

Fig 3 Output of Air Canvas

The camera starts capturing the movement of the hand enabling it to capture it the live feed. It is done by capture the real time video frame by frame.After capturing the gesture,it recognises the gesture made in the frame and then display it in the form of text in the live feed.Lastly,the text displayed is converted into voice and the user is able to hear the name of the sign made by using the hand.(**Fig. 4**)
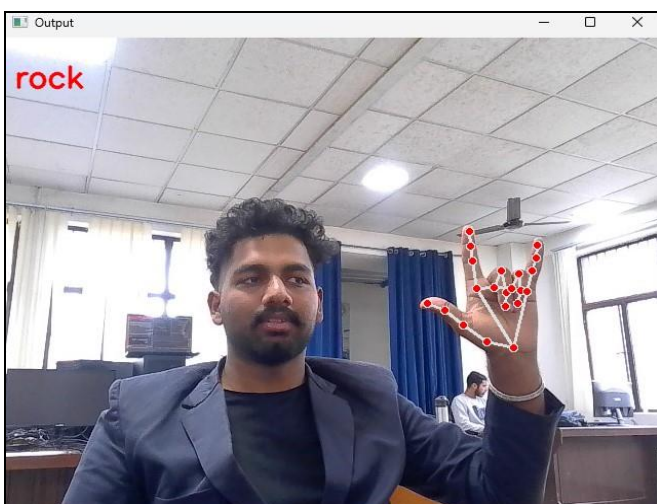

Fig 4 Output of Hand Sign Detection

V. CONCLUSION

The paper, "A Canvas of Air and Signs," proposed an innovative system that integrates air canvas technology with real-time sign language recognition. This first-of-its-kind approach creates a dynamic learning platform and pushes the boundaries of human-computer interaction. Utilizing sophisticated machine learning and computer vision algorithms, the system empowers users to not just manipulate and create digital content in mid-air, but also to seamlessly translate sign language into spoken words. This innovation bridges the communication gap for the Hearing Impaired and mute community, providing them with a powerful tool for self-expression and interaction with the broader world. The proposed system has the potential to unlock groundbreaking educational opportunities and fundamentally reshape how humans interact with computers.

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