

# Space Board Optimized with Gesture Control

**Suraj Rasal**

*Assistant Professor*

*Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune, India*

**Kriti Mehrotra**

*Student*

*Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune, India*

**Abhinav Deep Rastogi**

*Student*

*Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune, India*

**Manu Sharma**

*Student*

*Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune, India*

## Abstract

SpaceBoard with Gesture Control is a topic of in-depth studies for many applications which are related to drawing or writing by just moving our bare fingers in the air. Air Canvas can write or draw anything on screen by just identifying the motion of a finger with the help of a camera using various mathematical algorithms. This recognition system helps in interaction with machine which, in turn leads to human-machine interaction. Here, we have proposed a system where we write in the free space with bare fingers without use of gloves or any kind of sensors. Air writing allows us to write letters, numbers and any character in free space using fingertip. The computer identifies hand landmarks in the human palm and let the user perform various functionalities via different hand gestures like writing, changing colors, and erasing. The main goal of this project is to gain maximum accuracy for the model and try to solve all the solvable possible errors. The programming language that we are using is python along with OpenCV and Mediapipe frameworks. This system is a software-based application and is comparatively fast, simple, and easy to use. One of the advantage is that it requires no other external device except a camera.

**Keywords: Air-Writing, Computer Vision, Gesture Control, Human Computer Interaction**

## I. INTRODUCTION

In today's digital era, the traditional way of writing is being replaced by writing digitally. Digital art and traditional art are related to each other and often dependent on each other. The traditional way of writing involves pen and paper, or chalk and black board. The main objective of digital method of writing is hand gesture recognition system. Writing digitally includes many methods of writing like using keyboard, digital pens, touch-screen surface, electronic hand gloves, etc. But in our project, we are using gesture recognition with machine learning algorithm using python programming language. It builds a natural interaction between user and application. Nowadays, technology is evolving rapidly. Hence, the requirement to develop natural human – computer interaction systems is increasing rapidly [1].

Keeping this fact in consideration, we as a team have tried to make the most out of this opportunity to design and present a technological tool that can be beneficial to all. We came across innumerable ideas, but out of all, one stood out and was more feasible and practically achievable which, thus resulted into our formulation for this project. In gesture control, image processing technique also important aspect with internet of things [2].

Gesture recognition system allows user to communicate and interact with the machine without any external devices. With the concept of gesture identification, it is possible to detect palm at the screen and the cursor will move accordingly. Gesture recognition can be achieved with techniques from image processing and computer vision. Sometime all data related to IoT should be securely deliver across the network if it is required [3]. The process includes ongoing work in the computer vision field on capturing gestures or general human movements by cameras which are connected to a computer. While securing the image based data, it's also important to have Internet Service Providers security [4]. Gesture can be defined as a motion of hands or any other body part which are made to emphasize speech. Scientifically, a gesture can be categorized distinctively into two categories: dynamic and static. It is necessary to explain all the static and dynamic beforehand for effective understanding of the full message. Gesture recognition is interpretation of user's movements by computing device. We have encountered our problem using OpenCV and python programming language [5].

Movement Detection through gesture control and recognition are used to achieve the objective of open space writing. The hand movements are tracked and then a mask is created. Further, it includes the steps of morphological functions on the mask which are Dilation and Erosion. For proper image based data synchronization, its access structure should be have advanced and proper technology [6]. The function of erosion is to reduce the impurities in the mask and then in dilation, eroded main mask is restored.

## II. RELATED WORK

Technology has become an indispensable and necessary part of our lives. Even the ones who cannot afford to be directly indulged in the usage of technology are affected or come in proximity of technology in some way or the other. Almost every single aspect of today's era has been revolutionized using technology. The area of object tracking and writing in air has also been touched before by fellow scholars. Generally, the object can be anything, from a fingertip to hand or any other external object. The addition of machine learning to this area gave it new heights, as it uses deep learning to operate on vast amount of raw, high dimensional data to learn different new hierarchical results.

In, 'Handwritten Text Recognition using Machine Learning Techniques in Application of NLP: The researchers proposes Handwriting Detection as a method or ability of a system to get and interpret the handwritten input from source such as documents, touch screen, photo graphs etc. Handwritten Text recognition is one of the area pattern recognition. The purpose of pattern recognition is to classify data or object of one of the categories. Handwriting recognition is understood as the task of changing a language represented in its spatial form of graphical marks into its symbolic form. Each script has a set of symbols, which are known as characters or letters, which have certain basic shapes. The agenda of handwriting recognition is to recognize input data or image correctly then analyze to many automatically processed systems. This system will be enhanced to detect the writings of different format. The auto recognition of handwritten text can be very useful in many application. [7]

In 'Text writing in the air: they have proposed a paper that presents a real time video based pointing method which allows sketching and writing of English text over air in front of mobile camera. As said above we have used and studied Open CV library. Further we have studied the existing image processing techniques used in vehicle number plate detection system [8]. The proposed technique have two main tasks: first it track the colored fingertip in the frames and then apply English OCR over plotted images in order to recognize the written characters. The, proposed method provides a natural human-system interaction in such way that it does not require keyboard, pen or glove etc for character input [9].

In, 'A Research on Digital Art using Machine Learning Algorithm: This paper proposes that Gesture recognition technology is the one which is used to identify human gestures with the help of different mathematical algorithms. This enables interaction with machine effectively leading to human-computer interaction. In this paper I have proposed a system of writing in the air with fingers without use of gloves and sensors. Air writing allows us to write characters and words in free space using fingertip colored with specific color. The color marker is placed at tip of user fingers. This helps the webcam to identify the movements of hand [5].

There are many downsides of previously implemented systems like inaccurate, some uses external hardware like sensors and wearable gloves , but the major problem these systems have is color based detection approach(HSV) which fails whenever some other same colored object is detected in the native environment of the user , which makes the software confused ,because it recognizes all such points on the screen as the marker point and hence start flickering , nullifying the whole agenda of the project [2], [8].

## III. METHODOLOGY

As we see there is a lot of past work related to drawing something in free space using the power of vision especially to gain maximum yield in terms of detection and accuracy of replicating the traced trajectory on the screen.

If we look towards the past work and its research and implementation they mostly used and utilized the HSV detection approach to accomplish this technique but when we started doing requirement analysis and feasibility study we figure out some limitations or drawbacks in the approach which is used in past projects and works that is the approach is made to detect the individual color in between the vision area of a respective camera module. That specific color is used as a lead which is used as a pivot color that is detected and traced but if there is any other object of the same color that comes under the vision of the camera then the model will fail to work properly.

So our model encounters this limitation with the power of machine learning using Mediaapipe Library. Media library gives the power of machine learning using Tensor Flow to detect 21 landmarks on human Palm. These landmarks are tracked with great accuracy in tough condition too which lead to a more accurate and efficient model in the current scenario. Our approach and implementation make the system color independent so the user doesn't have to worry about colors and these landmarks also help users to define various ready to use gesture control features in our system which make it so unique that is, two finger-Selection Mode, All finger Close- Cleanup All screen, etc.

**A. Architecture**

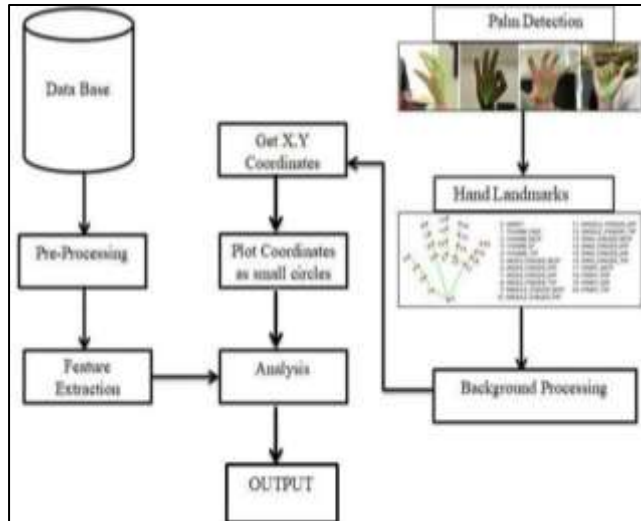


Fig. 1: Architecture of the proposed system [10]

**B. Flowchart**

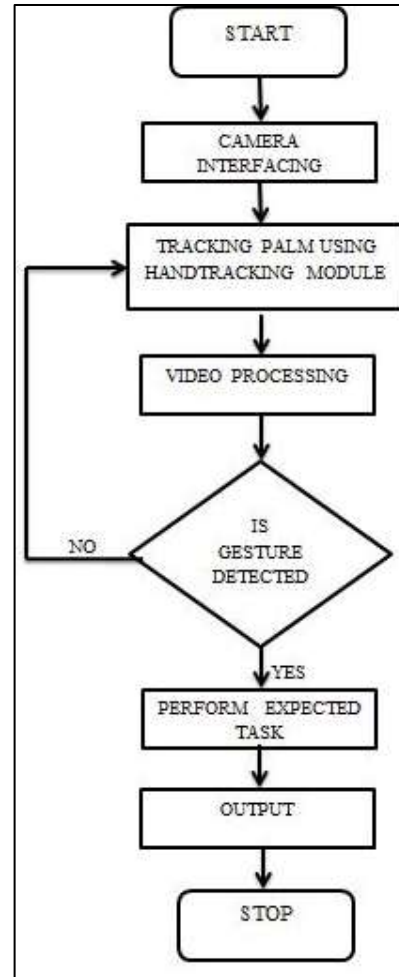


Fig. 2: Flow chart of proposed system working [10]

The flow of the whole system goes with starting and invoking the python file which contains all the code where OpenCV helps to detect the camera module in a hardware system.

The highly interactive User interface is drawn over the camera interface so the user can use various features direct from space as he or she can do over on the screen. Then when the camera interface is started capturing videos which again processed by OpenCV and Mediapipe so the detect the Palm or landmarks on Palm. Then while detecting landmarks on Palm if the desired landmarks combination is detected it will trigger the respective function which leads to performing the respective feature working which is associated with that gesture and on the same screen the output trajectory is plotted which exactly seems like you are drawing over on-screen from free space.

**C. Palm Detection with MediaPipe**

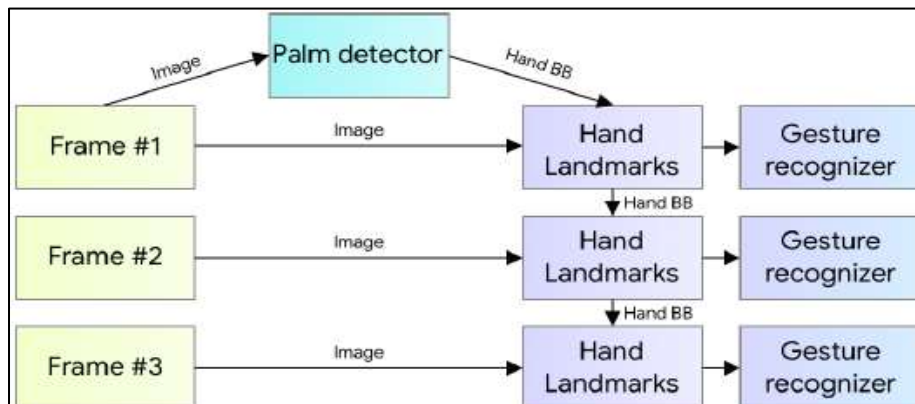


Fig. 3: Palm Detection with MediaPipe [11]

MediaPipe Hands utilizes an ML pipeline consisting of multiple models working together: A palm detection model that operates on the full image and returns an oriented hand bounding box. A hand landmark model that operates on the cropped image region defined by the palm detector and returns high-fidelity 3D hand keypoints.

After the palm detection over the whole image our subsequent hand landmark model performs precise keypoint localization of 21 3D hand-knuckle coordinates inside the detected hand regions via regression that is direct coordinate prediction. The model learns a consistent internal hand pose representation and is robust even to partially visible hands and self-occlusions [11].

#### **D. Applications of the proposed work:**

The major application of this hand gesture recognition framework is to provide ease of online education to both, students and teachers. Especially in this pandemic time, online education was the only mode of studying available, and using graphic tablets and other costly equipment isn't feasible for everyone. The proposed framework can replace such costly hardware. In future, a browser extension can be developed of this framework to easily connect it to any educational website.

Another application can be an optimized conversation app for especially abled people in which we can the framework can be trained using data of possible hand signals for conversation

### **IV. CONCLUSION**

In this paper, we have developed a system for writing in air using a webcam. The system was developed using Python Language, OpenCV and Mediapipe. With the help of this system a user can easily interact with computer by simply writing in air for online education or any other drawing purposes. This system provides highest accuracy of words and characters as well as this system removes the issue of color sensitivity of HSV model framework since it does not focus on color of fingertip rather than it detects the palm and uses different gestures for different functions and hence do not flicker while writing if same color as of the marker comes in surrounding of the user. In future more colors and more gestures can be added to the system. Also, we can create a browser extension in future to link this framework to any website. The results suggest that linking machine learning with opencv can produce effective system for air-writing which removes the issues of existing systems.

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