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# A Research on Digital Art using Machine Learning Algorithm

Megha S. Beedkar[1], Arti Wadhekar*

[1]*Student *Assistant Professor*

*Department of Electronics and Telecommunication*

*Deogiri Institute of Engineering and Management Studies Aurangabad, India*

***Abstract*— Gesture recognition technology is the one which is used to identify human gestures with the help of different mathematical algorithms. In this hand gesture recognition system has received a great attention as well as importance from last few years because of its growing application area in various fields of technology. 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. For this we have used python programming. The pictures drawn by the user can be stored at any platform defined by the user.**

***Keywords*— Gesture recognition technology, hand gesture recognition, human-computer interaction air writing, python programming**

## 1. INTRODUCTION

In the era of digital world, traditional art of writing is being replaced by digital art. Digital art refers to forms of expression and transmission of art form with digital form. Relying on modern science and technology is the distinctive characteristics of the digital manifestation. Traditional art refers to the art form which is created before the digital art. From the recipient to analyse, it can simply be divided into visual art, audio art, audio-visual art and audio-visual imaginary art, which includes literature, painting, sculpture, architecture, music, dance, drama and other works of art. Digital art and traditional art are interrelated and interdependent. Social development is not a people's will, but the needs of human life are the main driving force anyway. The same situation happens in art. In the present circumstances, digital art and traditional art are inclusive of the symbiotic state, so we need to systematically understand the basic knowledge of the form between digital art and traditional art.

The traditional way includes pen and paper, chalk and board method of writing. The essential aim of digital art is of building hand gesture recognition system to write digitally. Digital art includes many ways of writing like by using keyboard, touch-screen surface, digital pen, stylus, using electronic hand gloves, etc. But in this system we are using hand gesture recognition with the use of machine learning algorithm by using python programming, which creates natural interaction between man and machine. With the advancement in technology, the need of development of natural 'human – computer interaction (HCI)'[10] systems to replace traditional systems is increasing rapidly.

'Gesture recognition enables humans to communicate with the machine and interact naturally without any mechanical devices. Using the concept of gesture recognition, it is Possible to point a finger at the computer screen so that the cursor will move accordingly. This could potentially make conventional input devices such as mouse, keypads and even Touch screens redundant. Gesture recognition can be conducted with techniques from computer vision and image processing. The literature includes on going work in the computer vision field on capturing gestures or more general human pose and movements by cameras connected to a computer. Gesture is defined a motion of limbs or any other body part which are made to emphasize speech. It can also be defined as an act or a remark made as a sign of attitude. A gesture is scientifically categorized into two distinctive categories: dynamic and static. It is necessary to explain all the static and dynamic gestures over a period of time in order to understand full message. Gesture recognition is interpretation of human motion by computing device' [1]. We approached our problem using OpenCV and python.

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## 2. RELATED WORK

Digital art using machine learning has revolutionized the entire stream of learning and has notably spread to the lengths and breadth of various domains of learning. Machine learning is used as a tool of deep learning which is able to operate on vast amount of row, high dimensional data to learn hierarchies of representations. Renowned artists are making use of machine learning to give new dimensions to their art and upgrade the artist within them. Artist like Robert Thomas uses algorithmic processing of smartphone sensors to transform musical composition.

In, 'Handwritten Text Recognition using Machine Learning Techniques in Application of NLP: This paper proposes Handwriting Detection is a technique or ability of a Computer to receive and interpret intelligible handwritten input from source such as paper documents, touch screen, photo graphs etc. Handwritten Text recognition is one of area pattern recognition. The purpose of pattern recognition is to categorizing or classification data or object of one of the classes or categories. Handwriting recognition is defined as the task of transforming a language represented in its spatial form of graphical marks into its symbolic representation. Each script has a set of icons, which are known as characters or letters, which have certain basic shapes. The goal of handwriting is to identify input characters or image correctly then analysed to many automated process systems. This system will be applied to detect the writings of different format. The development of handwriting is more sophisticated, which is found various kinds of handwritten character such as digit, numeral, cursive script, symbols, and scripts including English and other languages. The automatic recognition of handwritten text can be extremely useful in many applications where it is necessary to process large volumes of handwritten data, such as recognition of addresses and postcodes on envelopes, interpretation of amounts on bank checks, document analysis, and verification of signatures. Therefore, computer is needed to be able to read document or data for ease of document processing'[3].

In, 'Handwritten Text Recognition: With Deep Learning and Android: This research paper offers a new solution to traditional handwriting recognition techniques using concepts of Deep learning and computer vision. An extension of MNIST digits dataset called the Emnist dataset has been used. It contains 62 classes with 0-9 digits and A-Z characters in both uppercase and lowercase. An application for Android, to detect handwritten text and convert it into digital form using Convolutional Neural Networks, abbreviated as CNN, for text classification and detection, has been created. Prior to that we pre-processed the dataset and applied various filters over it. We designed an android application using Android Studio and linked our handwriting text recognition program using tensorflow libraries. The layout of the application has been kept simple for demonstration purpose. It uses a protobuf file and tensorflow interface to use the trained keras graph to predict alphanumeric characters drawn using a finger'[4].

In, 'Inertial Pen Based Alphabet Recognition using KNN Classifier: In today's electronics world human machine interface is important part. Pen with inbuilt inertial sensors devices capture human handwriting or drawing motions in real-time and use the sensor data for recognition. An inertial sensor based Inertial pen consist of an inertial sensor MPU 9150(accelerometer gyroscope and magnetometer), microcontroller, and a wireless transmission module, for sensing and collecting movement data for writing alphabet. The sensor data is received and processed for alphabets, recognition. The recognition algorithm composes of the steps of sensor data acquisition, signal pre-processing, feature generation, feature selection, and classification. KNN Classifiers for classification among 26 capital alphabets classes is built. The project aims at to validate the effectiveness of the inertial pen based motion data acquisition and recognition of class of test sample from among 26 classes. The recognition accuracy achieved is 82%. The recognition accuracy of 93 % is achieved for recognition of four gestures'[6].

In, 'An Inertial Pen With Dynamic Time Warping Recognizer for Handwriting and Gesture Recognition: This paper presents an inertial-sensor-based digital pen (inertial pen) and its associated dynamic time warping (DTW)-based recognition algorithm for handwriting and gesture recognition. Users hold the inertial pen to write numerals or English lowercase letters and make hand gestures with their preferred handheld style and speed. The inertial signals generated by hand motions are wirelessly transmitted to a computer for online recognition. The proposed DTW-based recognition

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algorithm includes the procedures of inertial signal acquisition, signal preprocessing, motion detection, template selection, and recognition. We integrate signals collected from an accelerometer, a gyroscope, and a magnetometer into a quaternion-based complementary filter for reducing the integral errors caused by the signal drift or intrinsic noise of the gyroscope, which might reduce the accuracy of the orientation estimation. Furthermore, we have developed a minimal intra-class to maximal inter-class based template selection method (min-max template selection method)for a DTW recognizer to obtain a superior class separation for improved recognition. Experimental results have successfully validated the effectiveness of the DTW-based recognition algorithm for online handwriting and gesture recognition using the inertial pen'[7].

There are different drawbacks of earlier implemented systems like some are very less accurate. Other one system required very bulky hardware like sensors and wearable gloves for hand gesture recognition which becomes very uncomfortable after some time. Some systems have very complex design. Hence to overcome this we developed the model of air writing based on machine learning language in which we used python and OpenCV.

## 3. METHODOLOGY

The methodology of the implemented system is explained in this section with the help of block diagram and flowchart.

### 3.1. BLOCK DIAGRAM

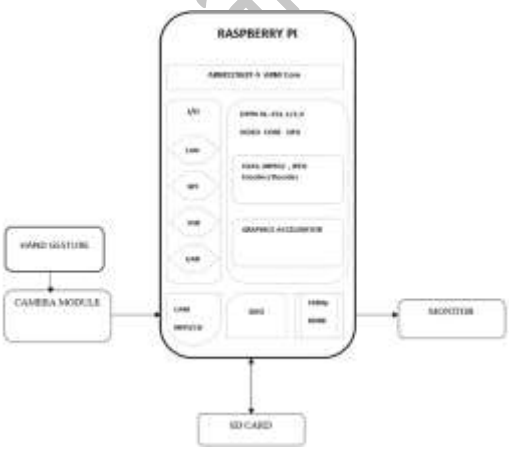


Fig. 1 System Block diagram

The system consists of ARM11 Raspberry Pi device, camera and Projector. There are colour markers placed at the tip of user's fingers. Marking the user's fingers with red, yellow, green and blue coloured tape helps the camera to recognize the hand gestures. Here we are using shiny green colour placed at user's fingertip. Captured gesture image is transferred to the ARM11 Raspberry Pi device for further processing. Projector receives the information from the ARM11 Raspberry Pi device & projects on to any particular surface or screen defined as output by the user. The whole process is achieved by code written in python language with the help of OpenCV.

### 3.2 FLOWCHART

In the following flowchart stepwise working of the system is given.

First of all as soon as we conduct the run operation we got the window of camera to detect the hand gesture. So camera interfacing is necessary to make sure an individual is present before his PC/laptop to perform the operation.

The fingertip movement serves as the primary input. The shiny green colour is tracked by the camera which is placed on fingertip of user.

Whatever user is going to write in air in front of the camera module so the processing of video is carried out here which extract the frame to be used which actually contained the writing.

Once the gesture is detected this implies that the algorithm is functional and next step need to be operated. Image is formed and by pressing 's' key on the keyboard image will be saved and mail is sent to its destination via email-id provided by the user. If it fails to detect the gesture then process of tracking colour on fingertip needs to be repeated. If we press 'q' key on the keyboard then the program will be stopped.

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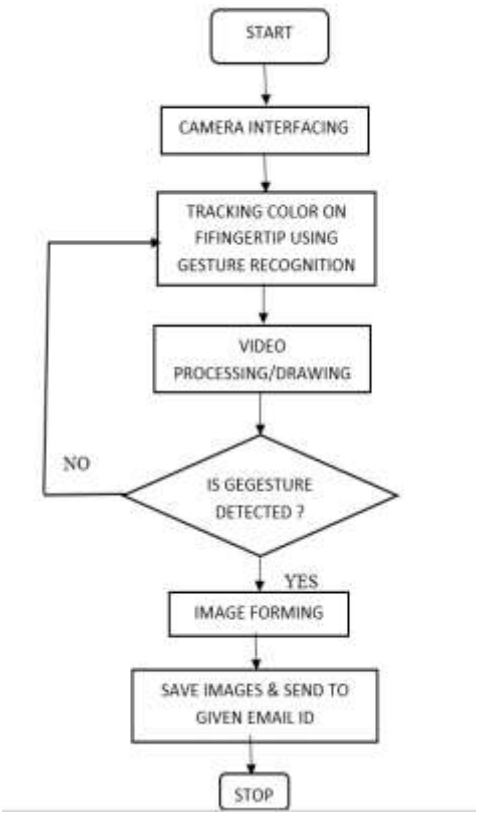


Fig. 2 flowchart of the program

So the development of the system is done. This includes fingertip detection, data collection, processing the captured image and finally saving it as image and document in folder and mail respectively.

## 4. PERFORMANCE ANALYSYS

Along with machine learning language like python we have used different algorithm to detect the object from image and video. In our project the specific green coloured fingertip of user is detected by masking other colours. This is achieved by using Haar cascade algorithm. Instead of using normal RGB color orders we have used HSV color model which gives more accurate color arrangement.

### 4.1. HAAR CASCADE ALGORITHM

Haar Cascade is a machine learning object detection algorithm used to identify objects in an image or video and based on the concept of features proposed by Paul Viola and Michael Jones in their paper "Rapid Object Detection using a Boosted Cascade of Simple Features" in 2001. It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. It is then used to detect objects in other images.

The algorithm has four stages:

1. Haar Feature Selection
2. Creating Integral Images
3. Adaboost Training
4. Cascading Classifiers

It is well known for being able to detect faces and body parts in an image, but can be trained to identify almost any object.[11] 'Initially, the algorithm needs a lot of positive images of faces and negative images without faces to train the classifier. Then we need to extract features from it. First step is to collect the Haar Features. A Haar feature considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel intensities in each region and calculates the difference between these sums.'[11] In OpenCV instead of RGB we used BGR ordering of their images.

### 4.2. HSV COLOR MODEL

To detect the shiny green color on fingertip of the user we have to set the minimum and maximum value of that green color. This is achieved by converting BGR colors into HSV (Hue Saturation, Value) color model.

'The HSV color model always appears in cone or cylinder shape which includes these three values.

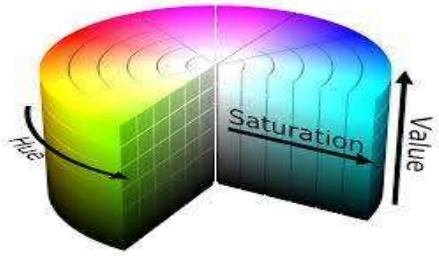


Fig. 3 HSV color solid cylinder

HUE

Hue is the color portion of the model, expressed as a number from 0 to 360 degrees:

- Red falls between 0 and 60 degrees.
- Yellow falls between 61 and 120 degrees.
- Green falls between 121 and 180 degrees.
- Cyan falls between 181 and 240 degrees.
- Blue falls between 241 and 300 degrees.
- Magenta falls between 301 and 360 degrees.

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SATURATION

Saturation describes the amount of gray in a particular color, from 0 to 100 percent. Reducing this component toward zero introduces more gray and produces a faded effect. Sometimes, saturation appears as a range from 0 to 1, where 0 is gray, and 1 is a primary color.

VALUE (OR BRIGHTNESS)

Value works in conjunction with saturation and describes the brightness or intensity of the color, from 0 to 100 percent, where 0 is completely black, and 100 is the brightest and reveals the most color. HSV better represents how people relate to colors than the RGB color model does'[12].

**5. RESULTS**

When the program code is running we get the different outputs which I have listed below.

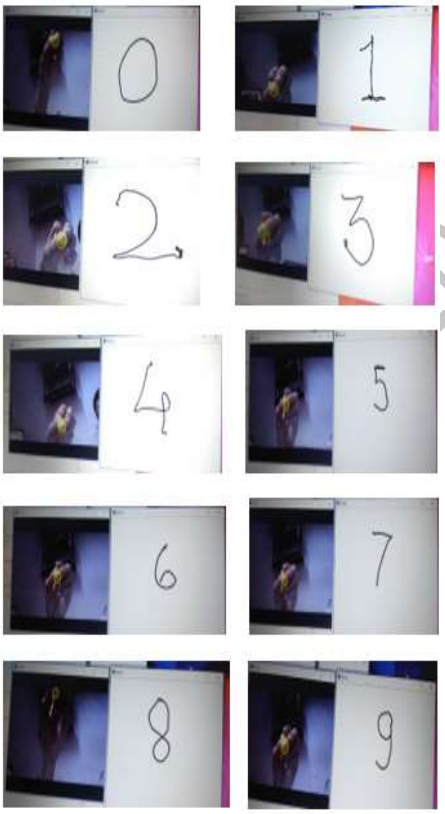


Fig. 4 digit writing in the air from 0 to 9

After drawing in the air with the fingertip there are two output windows are seen on the desktop. So while writing if you want to clear the board then by pressing 'c' on keyboard it will clear the board to write again. For saving whatever written on output window then simply press 's' key on keyboard and the written text will be saved as document to email-id provided by the user. A message is displayed on output screen as ' image is saved' and ' email has been sent successfully'. If 'q' key is pressed then the program will be halt and camera is stopped automatically. This finishes our whole process of getting output.

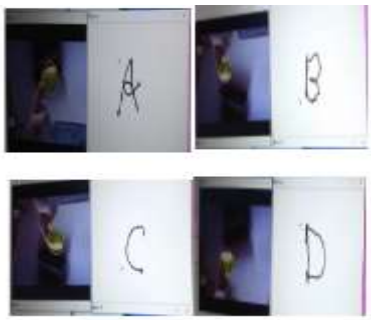


Fig. 5 Alphabets written on output

As shown above we not only write digits and alphabets but also can write words and characters. This implies that we can write or draw anything we want n number of times and can save it easily. For writing words and characters we use single stroke method of writng. The written character detection is possible with the use of Haar cascade algorithm.


Fig. 6 written words displayed at output

The output obtained are digits, alphabets, characters and words are drawn with air writing phenomenon are displayed in above figures.

## 6. CONCLUSION

In this paper, we have developed an air writing system using a webcam and python language programming with the help of OpenCV. 'With the help of this system a person can easily interact with computer anywhere, and they can also use this application for virtual classroom and drawing applications' [13]. The highest recognition accuracy of words and characters is achieved. Also recognition of same color applied to two or more fingertips of the user is not achieved in this. Only single fingertip with assigned color is detected. Therefore in future work we can add more colors to be detected by the users hand gesture. We can developed android application based on this with some modifications in near future. So we can use this system as a notice board at educational institution and at public transport system as well. We can also use it in various applications of virtual reality and augmented reality. We can conclude that machine learning is the future and the future of machine learning is going to be very bright.

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