



# AIR-DRAWN CHARACTER RECOGNITION USING AI AND PATTERN RECOGNITION METHODOLOGY

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**Abstract:** In pattern recognition applications, Handwritten Character Recognition is considered a central issue in a practical manner. Reading handwritten information like examination answer sheets is still difficult for many of us because each of us has a different interpretation style. As the world progresses towards digitization, converting handwritten information to a readable format reduces the complication. The proposed approach will be favourable for the readers as it gives a better understanding of the information. With the help of Machine Learning and Python, it is easier to recognize handwritten human characters and classify them correspondingly to a digital format. The handwritten patterns can be recognized and classified according to a digital format with human-level accuracy. The paper deals with predicting the real-time handwritten characters in the air. OpenCV python library is used for detecting the patterns, and the detected patterns are expected to have a human-level accuracy using a deep learning framework. DL has a massive set of pattern recognition tools which can apply to image processing, speech recognition, natural language processing, and has a remarkable capability to find out a solution for complex machine learning problems. The paper presents an innovative method for online handwritten character detection, and the objective is to ensure an effective and reliable approach to the recognition of handwritten characters.

**IndexTerms:** Handwritten Recognition (HWR), optical scanning (OCR), computervision (CV), and pattern recognition (PR)

## I. INTRODUCTION

Developing such a machine needs a proper understanding of the classification of characters and the difference between the minor and major points to properly differentiate between different textures, which can be only possible with appropriate training and testing. The ability of a computer to understand and receive comprehensible handwritten input from sources such as user-input touch screens, paper documents, and other devices is said to be Handwritten Recognition (HWR). The depiction of the written text may be sensed from a piece of paper by optical scanning (OCR), intelligent word recognition, or user input. Alternatively, the movements of the fingertip may be sensed online; for example, more clues will be available in the case of a Pen-based computer screen surface, which is an easier task. HWR can be done in two ways, one is online handwritten recognition, and another one is offline handwritten recognition. Online handwritten recognition system takes the input at a run time, whereas Offline handwritten recognition works on scanned images. Offline handwritten is the hardest one to discover handwriting. Therefore, converting the handwritten information to readable format reduces the complication, which results in a better understanding of the information. It deals with predicting human handwritten alphabets in the air. Thus, handwritten character recognition can be defined as the ability of a device or computer that accepts input in the form of handwritten text from sources such as photographs, images, printed documents, or input stream from other devices direct input to the touch screen, which is interpreted as text is widely used.

An example is intelligent phones or tablets with a touch screen that can use handwriting by stylus or finger, input as number input or can be text. The handwritten characters are not perfect, so it's a difficult task for the machine. HCR is the solution to the problem that takes the input at runtime and prediction of that particular character accurately. A handwritten character recognition system is used to visualize artificial neural networks.

## II. NEED FOR STUDY

Human beings tend to look for ways to possess more brilliant work nowadays. They target using compatible devices. In terms of handwriting, instead of maintaining outstanding handwriting expertise, systems or models can be implemented for the recognition of

writing in a better way because newer ideas and different technologies are developing day by day. In the current generation, machines are designed that behaves exactly like a human. But some of the human features cannot be deployed. Handwriting still has significant importance in human lives. Although, the handwriting will be different for each individual. Sometimes it is tough to read and recognize handwritten text by humans. It results in erroneous detection of the hand in writing. Optical character recognition is a popularly used recognition method for converting human written text into a form that can be understood by machines. Even though there are devices or techniques that are available for the detection of handwritten alphabets or sentence form, the identification of such characters or text is nevertheless demanding and exigent in the field of PR. As a result, the interaction or connection between humans and machines can also be improved. Developing a system for identifying and detecting human written characters can be convenient for numerous applications. Several research works can be done for the same. Various technologies and algorithm-based techniques can be utilized and employed to expand and grow recognition-based methods. And also, instead of using many devices for the deployment, fewer devices are recommended. The proposed approach completely demolishes the need for typing. Recognition is also considered a central problem in PR, CV, etc. As handwriting varies from one person to another person, every time so often, it is strenuous to identify the human written characters or words. A central problem in such type of system is the contortion, unevenness and invariability of the patterns. Handwriting also plays a significant role in forensics which includes the investigation of the crime, testing of DNA, QDEs etc. Thus, it minimizes the burdens of humans, making a system without human intervention and can increase the speed of the complete procedure. Also, the system aids physically challenged persons, those who cannot hear or talk, in interpreting and auditioning for the English language. Because they utilize the movements of their hand or finger to interact with another person, which serves as the basis of motivation for this work. Elderly people sometimes observe and discover that it is tough to type the characters or text in the in-built keyboard of the smartphone. So, it can be more suitable or appropriate if they are able to draw in the gestures corresponding to the particular alphabet in an atmosphere or air. In recent times, It is a fascinating field if one can draw the gestures or alphabet directly in the air.

### III. LITERATURE SURVEY

A literature review justifies what has been published on a specific topic by researchers and accredited scholars. It comprises the current knowledge, which includes substantive findings and methodological and theoretical contributions to a particular case. Literature reviews use secondary sources, and it does not report original or new experimental work. A literature review lets us gain and demonstrate skills in information-seeking and critical appraisal.

Handwritten character recognition (HCR) is a perpetual field of exploration in Artificial Intelligence (AI), computer vision (CV), and pattern recognition (PR). Human beings can understand different handwritings easily using his/her learning and intelligence. Machine learning (ML) and AI aid us in the induction of the same ability into machines. If a computer is making handwriting identification, it is stated to be able to gather and detect characters in photos, touch display devices, paper files, and other different devices. Then it converts them into device-encoded form, and the field that deals with this is known as Optical Character Recognition (OCR). Before the widespread adoption of digital technologies, there was an expanding fervour for digitizing complete and thorough measures of existing records & books. An easy way of performing operations like searching & sorting is achieved through digitized text because it can be quickly processed for numerous tasks.

OCR can be divided into two groups: Printed Character Recognition (PCR) & Handwritten Character Recognition (HCR). PCR is comparatively easier than HCR as the numbers of different printable fonts (like Calibri, Algerian etc.) are significantly less than the number of different handwritings, which are highly diverse. Furthermore, HCR is broadly classified into Offline Recognition and Online Recognition. Online Recognition is a real-time process in which the characters are recognized while the user writes the document. And in Offline Recognition, the feelings of already registered documents are recognized. Tools like images (using the camera) or optical scanners are generally used in offline Recognition. Different image processing & Neural Network models are commonly used for this type of task.

Offline Recognition is more complicated, less accurate and has a low recognition rate because of not having pen strokes of users. But in the case of Online Recognition, pen strokes of users are available, and hence it is easier and more accurate, and the Recognition rate is higher there. OCR includes five phases. The accuracy and efficiency of the system bank on the dataset used & the methodology. In the review, a detailed comparison is shown between some research works done in this field. On the basis of this, a conclusion can be made about accuracy, performance and some other parameters for various methodologies. There are numerous applications of handwritten character recognition, which is now utilized widely in ICR and OCR frameworks. Some uses include amounts written on bank cheques, different hand-filled forms, reading addresses from postal letters, etc. Furthermore, HCR is used for digitizing manuscripts & ancient scrolls and thus preserving their content [1].

[9]Writing linguistic letters in open space while utilising all six hand motion degrees is known as "air writing." Several approaches to air-writing have been put forth by researchers, each of which relies on one or more pieces of specialised external gear, raising production costs and lowering hardware redundancy. Our solution eliminates the need for extra hardware and increases hardware redundancy by using a generic webcam to detect and recognise the characters that a user has digitally typed at their discretion. The tracker or tracking object's mask is created using this method using HSV colour space, and the mask is then refined using morphological processes. Using this approach, the user is allowed to choose a writing item for tracking, that is, any colour, shape, or substance. The object's mask's trajectory is tracked and visualised on a virtual window. The convolutional neural network is used to recognise the air-written character (CNN). The Devanagari handwritten character dataset has 36 different classes (ka-kya), the MNIST dataset has ten different classes (0–9), the English handwritten characters dataset has 26 different types (A–Z), and the Devanagari handwritten digits dataset has ten classes (0–9). Also, a custom dataset of air-written digits (0–9) with three examples from each class and 20 distinct people is used to test the CNN. For isolated characters on the same datasets, the suggested system's accuracy was 99.75%, 99.73%, 99.13%, 99.97%, and 99.81%.

### IV. SYSTEM REQUIREMENTS

#### Python

Python is the world's fastest-growing and most popular programming language among software engineers, mathematicians, scientists, data analysts, networking engineers, and accountants. It's a very beginner-friendly programming language. Python has been used for various tasks such as visualization, analysis of data, AI, automation and ML. Instead of boring, repetitive tasks such as copying files and folders around, renaming them, and uploading to a server, the python scripts can be used to easily automate all that and thus save time. Python can also be used to develop mobile, web, and desktop applications as well as software testing or even hacking. Thus, it is a multi-purpose language. So, it enables complex issues to be solved more quickly and with fewer lines of code. Complex tasks like memory management can be completed because it is a high-level language. Python can

be used to create and run python programmes on Windows, Mac OS X, and Linux. It involves various libraries, tools and frameworks. Its python's simplicity & elegance has made it grow way than the other programming languages.

## OpenCV

OpenCV is an open computer vision library that performs image analysis, video analysis, image processing, and manipulation. It can be used to load images, draw things onto images, how facial detections and recognitions can be done, how object detection is done, how tracking is done, and how objects move around in an image or video. It is easy to use. It is a python package which is installed using the pip command. OpenCV is available in other programming languages as well. It is imported using cv2. To load an image in OpenCV, the path of the image has to be loaded. The images to be loaded can be in JPEG and PNG formats. By default, cv2 will load the images in the blue, green, and red pattern of colour. The image can be loaded in greyscale or as its regular-coloured image, whatever it normally looks like or can be loaded without considering transparency. Now, the image can be displayed using the command in the show. It will create a window and has some label for it. It uses the command wait for Key, i.e., it waits an infinite amount of time to press any key on the keyboard. Then the window is closed by using the command destroy All Windows.

## Media pipe

A Python package called Media Pipe can find hand and face landmarks. To find every face and hand landmark, we'll use a Holistic model from Media Pipe Solutions. Also, we'll show how to access several facial and skeletal features that can be applied to a variety of computer vision tasks, including the recognition of sign languages and the identification of tiredness.

Recognizing the shape and motion of hands can dramatically improve the user experience across a variety of technological domains and platforms. For instance, it can provide the foundation for hand gesture control and sign language comprehension. It can also make it possible for digital information and material to be superimposed on top of the real world in augmented reality. Although it comes effortlessly to individuals, robust real-time hand perception is an extremely difficult computer vision problem due to the fact that hands frequently occlude themselves or each other and lack high contrast patterns. A high-fidelity hand and finger tracking solution are MediaPipe Hands. It uses machine learning (ML) to deduce 21 3D hand landmarks from a single image. Our solution delivers real-time performance on a cell phone and even scales to several hands, unlike the existing state-of-the-art systems, which mostly rely on powerful desktop environments for inference. We anticipate that making this hand perception functionality available to a larger research and development audience will lead to the creation of innovative use cases, igniting new research directions.

## NumPY

A Python package called NumPy. Its acronym is "Numerical Python." It is a library made up of routines for handling arrays and multidimensional array objects. Numeric, the ancestor of NumPy, was developed by Jim Hugunin. Another package, Numeric array, was also developed, having some additional functionalities. In 2005, Travis Oliphant created the NumPy package by incorporating the features of the Numeric array into the Numeric package. There are many contributors to this open-source project.

The N-dimensional array type known as the array is the most significant object defined in NumPy. The collection of identically categorized things is described. A zero-based index can be used to access items in the collection. A ndarray's items all take up the same amount of space as a memory block. Every item in the array is a data-type object (called dtype). A Python object of one of the arrays scalar types represents each item that is retrieved from an array object (via slicing).

## V. METHODOLOGY

The data must be collected, which is required to design the model. The imported dataset has to be analyzed. The dataset must be cleaned and prepared for the analysis process. It returns two tuples. It's a built-in data type used to store data items within a single variable. One of the Tuple will hold the data and label required for training. Another tuple contains the data and title required for testing. Then the preliminary processing of data should be done. It has a series of steps+ that the dataset must undergo to transform the data into a form which can be processed easier and more effectively. Various operations should be done in this step, including reshaping the intensity of the pixels converted into float data type and normalizing the data such that values fall between 0 and 1. Reshaping is needed, as the original label and data are provided in DL. Each image will have 28x28 dimensions, which further results in a total of 784 intensities of the pixel. After reshaping, the pixel intensities must be changed to float 32 data type. The normalizing step is to improve sufficiency. Then the model is created. Next, the model has to be compiled for learning & optimization. Then the model is to be fitted using the dataset. Finally, the model is evaluated on the unseen test dataset.

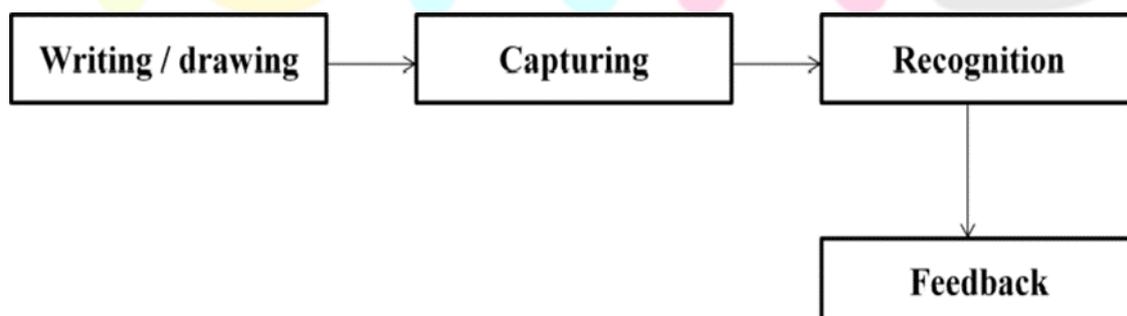


Figure 4.1 Basic Working Of ADCR

## Model Building

The model will use the background image that the user drew in empty space and forecast how the character would be drawn from there. The key objective is to have the model correctly forecast the majority of the inputs. The model makes precise predictions using the letters from a to z. The pip command, a package management tool created in Python and used to install Python packages, can be used

to obtain any necessary packages. Before the model has been trained, accuracy will be lower. In order to gauge categorization performance, a scoring function is implemented. To determine accuracy, only testing data are used.

### The Camera Used in The Model

The frames recorded by a laptop or PC's webcam serve as the foundation for the proposed Model. As seen in Figure 4.2, the web camera will begin recording video after the video capture object is created using the Python computer vision package OpenCV. The virtual AI system receives frames from the web camera.



**Figure 4.2 Capturing video using the webcam (computer vision)**

The operations such as erosion, morphology (opening), and dilation are applied to the image. Erosion decreases the thickness of the boundaries of the bright area of the image. The morphology opening is only applied here. It is used to remove noise. Morphology closing is used to remove the noise in the bright area. But that is not performed here. Dilation is the opposite of erosion, which increases the thickness of the boundaries of the bright area of the image. The cap of a water bottle is taken to detect the blue colour object. Each character is drawn using the tip of a finger, and the tip of two fingers is used to stop writing in the air. Figure 4.3 represents the tip of a finger used for writing in the air, and figure 4.4 shows the tip of two fingers used to stop writing.



**Figure 4.3 the tip of finger used for writing in air**

### Selecting the option

Using the tip Id of the specific finger we located using the Media-Pipe and the corresponding coordinates of the fingers that are up, as shown in Figure 4.5, we can determine which finger is up. Then, following that determination, the specific mouse function is carried out.



Figure 4.4 the tip of two fingers used to stop writing.

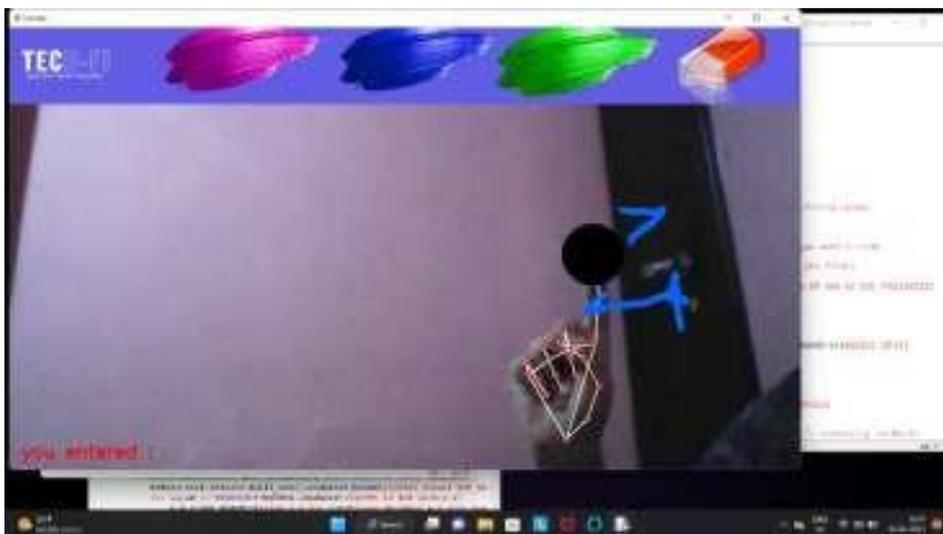


Figure 4.5 selecting an option

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## Character Prediction

It is the last module. The model predicts the word drawn in the air in life. The word is drawn in the air, and at the same time, the model will predict that character. If any letter is drawn, then it deletes that respective alphabet once we select the option eraser and erase it. s. Then you need to connect all the detected points with a line. If you pass this image to the model, it predicts the alphabet. The text “you entered:” will be shown in the resulting screen or frame, and the result window appears as a result of the OpenCV library. The main aim is to make the model predict most of the images or inputs accurately. Figure 4.6 depicts the erasing of the character written on the window. Figure 4.7 depicts the image of the resulting window that shows the prediction of the alphabet drawn and where the user can draw the characters in real-time.



**Figure 4.6 Erasing the character written on the window**



**Figure 4.7 Resulting Screen Of The Model**

## VI. RESULT AND DISCUSSION

Air-drawn Character Recognition is a recognition system in which you just need a camera and a fingertip that can be used as a pen. The model predicts the 26 alphabets in the English language. First of all, you need to open the webcam. To write any letter or word, one finger is used. It is considered a pen. Instead of writing the letters in paper or notebook or typing in the keyboard, the words are drawn or written in the air. Two fingers are used to stop writing and select the option. The user can write the characters live by showing one finger and can simply show two fingers to stop. If you open the webcam, then a window appears where you can draw the letters, and it contains three different colours to draw and an eraser. It also contains the prediction of the alphabet that you are drawing. Two fingers are used to select the eraser and colour that you want to draw. If the alphabet ‘a’ is drawn, then it must show the prediction as ‘a’. The letters are case-sensitive. The letter ‘F’ on your keyboard is used to predict the word you draw, and the letter ‘S’ is used to search for the word in google. The developed recognition system enables one to write or draw alphabets or words in the air and make exact predictions. It increases the flexibility of using the solution.

## VII. CONCLUSION

HCR is the first step in the wide field of AI and CV. It can be expanded to include a live person’s handwriting, thus eliminating the necessity for later typing. ADCR system enables one to draw or write the characters in the air instead of a notebook or paper. A computer that recognizes handwriting is said to acquire and recognize the characters or alphabets in images, touch screen gadgets, paper-based

documents and other sources, transforming the human written letters into a form that the machines can read and understand. Optical character recognition is a popular method where it is used. And its use cases are also found in the highly intelligent alphabet or character recognition systems. And lastly, it helps much to the improvement of the interface between humans and robotic processes in the processes of automation and machines in a variety of uses. Several studies have been concentrating on new approaches & techniques that would speed up the processing power while giving higher precision rates in the recognition.

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