# "AI For Penmanship Acknowledgment

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**Abstract**

With current data on a certain topic, machine learning aims to find hidden patterns and information in the data. In order to perform machine learning, we may use mathematical functions and ideas to extract hidden information. It is one of the most common uses of machine learning (ML). It is common practice to identify patterns using a huge collection of images. Pattern recognition applied to an image is what handwriting recognition uses. Computers may be trained to recognize letters and numbers in any language displayed in a picture by using these techniques. There are a number of ways to identify handwritten characters. In this article, we will go through some of the techniques.

## 1.Introduction

Recognition of objects has become one of the most sought-after tasks in machine learning. Examples of object recognition include face recognition, handwriting recognition, disease diagnosis, and so on. All of these things are possible when working with a huge collection of picture data. There will be both positive and negative data included in this picture data collection with respect to that subject matter. A better classification of unknown data helps the algorithm do its job better. This innovative technique of hand writing recognition will be helpful in the twenty-first century[1]. With its help, additional features may be built onto it. Blind people cannot read newspapers unless they are presented in braille format, for example. The algorithm may be taught to detect characters in a newspaper and then used to

turn the text into voice. People who are visually impaired may find this useful in their everyday lives[11]. Translation might be another use for handwriting recognition. Using a handwriting

to hand-write recognition and artificial intelligence. There is a basic case for all of the above-mentioned possibilities, which is hand writing recognition. There are several kinds of Optical Character Recognition, and one is the recognition of handwriting (OCR).
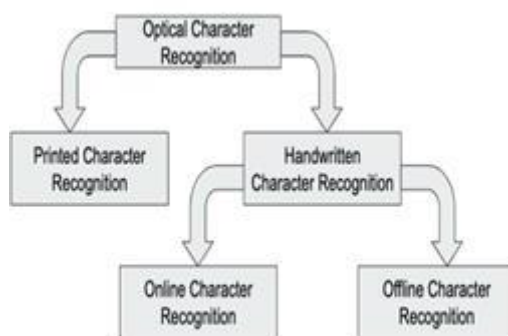
recognition algorithm, a person working with a non-native language may simply transmit an image to the algorithm. Images may be recognized using this method, which then converts the characters to text. This allows the text to be translated into the target language.

Using handwriting recognition to handle massive sets of paper documents, such as response scripts[10], is another use case. Answer scripts may be reviewed without human intervention thanks

OCR is the process of recognizing handwritten or printed text. OCR uses a camera to take a picture of the document, which may then be converted to other forms like PDFs. A character-recognition algorithm is then used to process the data file. Certain situations may benefit greatly from this[2].
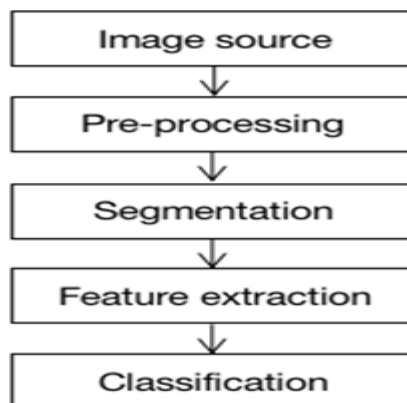
**Figure1:**classificationofOpticalCharacterRecognition

**Figure2:**Phasesofhand-writerecognition

Printed character recognition and handwriting character recognition are two of the OCR variants. printed character recognition, as its name imply is the recognition of characters in images of printed media. Recognition of characters written by humans or with human interaction is known as handwriting recognition[3].[4] It may be separated into two categories: online character recognition and off-line character recognition. It is possible to extract text and words from a picture using offline character recognition. Online character identification might be a bit of a challenge. You can not predict it. Recognition of character data while writing is a must. An electric pen and a specific writing pad are required[7]. You can tell a written character's style just by looking at how the pen moves. Visual classification of optical character recognition (OCR) may be shown in Figure 1, whereas hand-write recognition (RW) can be seen in Figure 2.

### *Imagesource*

Offline hand-written character recognition is at this stage. Any digital tool may be used as an image source. The picture is captured using either a scanner or a camera and then sent to the next step.

### *Pre-processing*

It is a set of operations that enhances the picture quality and hence the accuracy of the image via pre-processing. The following pre-processing methods are used for handwriting recognition.

a) Noise-removal:-Image noise reduction is the method of eliminating it. Smoothing the image may also be done by lowering the amount of undesirable signals in the picture. Many algorithms exist to eliminate picture noise. Gaussian filtering technique, Min-max filtering method, Median filter, etc. are some examples.

b) Binarization:- Converting gray-scale or color images to binary images is the purpose of this process. ' Binary pictures consist only of the digits 0 or 1. Images are divided into 0s and 1s depending on a fixed value. Else, it is set to 1, and otherwise it uses a constant to determine whether or not to use 0.

### 2. Segmentation

This is the process of separating individual characters from a larger picture. Segmentation may be done in two ways. There are two types of segmentation: implicit and explicit. This technique does not need segmentation to identify the words. As a result of character extraction in explicit segmentation[8], words are anticipated.

### Feature-extraction

This is where the algorithm for recognition begins, and it is critical to the process. Each character has its own distinct characteristics. It consists of a set of rules, each of which describes a certain characteristic of a character. In this step, characteristics like these are extracted.

### Classification

The training should be complete at this point, and input data testing may begin. Matching rules are given probability based on testing data that passes all of the

following steps. Using the rule with the best chance of success, the associated class-label is given recognition.

## 2. LiteratureSurvey

### *UsingCNN*

Convolution Neural Network (CNN) is the abbreviation for CNN. Coiling and twisting are both examples of convolution. The human brain is a neural network. Inspired by the human brain[9], neural networks are built.[10] Images are often classified using CNNs. When a new layer is added to the CNN, it does so in response to the situation. An excellent handwritten text recognition system was suggested by Ahmed Mahdi Obaid and his colleagues utilizing two separate learning algorithms. In terms of accuracy and training time, Scaled Conjugate Gradient outperformed the Resilient Back-propagation algorithm in a comparable setup test. '

[2] Salma ShofiaRosyda and his colleagues[3] outlined the network's basic three tiers.

1. Convolutionlayer
2. Poolinglayer
3. Fullyconnectedlayer

### *Convolutionlayer*

Image categorization is based on the convolution layer's ability to recognize patterns. Deep Learning was proposed by Jagan Mohan Reddy D. and his colleagues as a means to improve the recognition rate of individual Telugu characters (DL).The picture matrix of width*height*depth is the input to this layer. The number of channels in an image is referred to as its depth in a matrix. The number of channels in a grayscale picture is one, but the number of channels in an RGB image is three. The RGB picture may be converted into a gray-scale

image and then used to train a CNN.

**Table1:**Example forafilter

| -1 | -1 | -1 |
|---|---|---|
| 1 | 1 | 1 |
| 0 | 0 | 0 |

The top left corner of the matrix is used to begin multiplying. Rather of the normal matrix multiplication, the multiplication is a dot product. We now go onto the next sub-matrix, with our dot product resultant now stored in our top-left corner. Every sub-matrix in the picture is multiplied by the filter.



**Figure3:**ImagesAfterprocessingand Convolution

Fig. 5 displays two photos. The left picture is the image after pre-processing. The picture on the right displays the result of convolution. The right image's vivid borders were achieved by using the filter stated above.

*Pooling layer*

Algorithm suggested in this paper aims to handle both the accuracy and temporal complexity of the problem. The suggested technique aims to deal with both variables while also being accurate and time-consuming. Using a variety of machine learning methods, S. M. Shamim and colleagues presented off-line handwritten digit recognition [10]. To identify digits, WEKA, Bayes Net, Support Vector Machine, Multilayer Perception, Nave Bayes, Random Forest, Random tree and J48 were used.
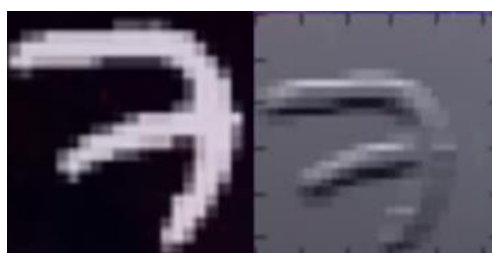
*Fullyconnectedlayer*

Pooling layer results are used to categorize the picture into a label by the fully connected layer's

primary goal. In most cases, the result of pooling is a matrix. A one-dimensional array is constructed from this matrix. Flattening is the technical term for this procedure. The values in the vector indicate the likelihood of certain characteristics of the item occurring. Voice and computer text conversion was suggested by Polaiah Bojja and colleagues, among others. Various consumer and health sector applications were examined using the model. Multiple layers of perceptrons are used to process the flattened values. To activate a function, the inputs are multiplied by weights. Most of this function is based on ReLU. Negative numbers are often removed from the input using this function. It is said that f(x)=max is the definition of ReLU (0,x). A ReLU function returns zero if the input is negative, and returns the input if it is not negative. Single CNN iteration follows this procedure. It is common for CNN to go through a number of these iterations. It is referred to as an Epoch. An increase in epochs results in an increase in the accuracy rate. After crossing the threshold, accuracy decreases.

***HandwritingrecognitionusingML.***

To identify handwriting, various algorithms are available. OCR (Optical Character Recognition) is a technology used to identify handwritten and printed documents. Unsupervised feature learning approaches for identifying digits were addressed by Yuval Netzer and his colleagues. Scannable and written digital documents are two different types of paper documents that might be referred to. Documents that have been written by hand are referred to as "handwritten"

A team led by Surya Nath RS and his colleagues proposed two kinds of language recognition systems.

OfflineHandwritingrecognition

OnlineHandwritingrecognition

*Offline Handwriting recognition:* In this case, the characters included in the papers may be recognized using the already-written and saved documents. It is up to the user to decide what characters they want to use. To identify mathematical expressions, this technique might be employed. Using this technology, students may scan a paper and have the Mathematical expression recognizer recognize equations and offer solutions.

*Online Handwritingrecognition:* It is not necessary to scan a document

in this instance since characters are typed using an electronic pen and then instantly recognized. In this situation, character recognition is based on the recognition of strokes.

In[3,5]manymethodsusedforrecognitionofHandwritingarelisted.

- ConvolutionalNeuralnetwork
- SemiIncrementalRecognition
- IncrementalRecognition
- Lineand wordsegmentation
- Partbased Method
- SlopeandSlantcorrectionmethod
- Ensemblemethod

1) IncrementalRecognitionmethod:

MeenuMohanet.al[6]proposedamethodusedtorecognizethecharactersincrementally.Here

- Firstthestrokeisreceivedfromuser
- Geometricfeatureisupdated

- Symbolisrecognized
- UpdatingCYKtable

2) LineandWordsegmentation

CNN approaches with the best accuracy and the Slope and Slant Correction Method with the lowest accuracy were addressed by Salma ShofiaRosyda and his colleagues [2]. Segmentation is an important stage in character recognition. Without segmentation, it is hard to tell what a particular sign or letter means. The following are the stages involved in the segmentation process:

- Findingareaofinterestbyviewingscannedimagesand cropimagery
- Noiseshouldberemovesfromimagebymethodcalledsubtraction.Pre-processingisdonetoremovethenoise onthe image
- Imageisthenconverted tobinarybyminingtextandbyr

emovingbackground.

- Houghtransformisusedforcorrectionandskewdetection

- LineSegmentationisdone usingHorizontalProjection.

3) PartBased Method

Thismethodisusedtorecognizetheobject.Propertiesofthismethodisgivenbelow:

- Singleimage shouldberepresentedbymultiplekeypoints

- Similarityofimagewilldependonimagehas keypointornot.

- SometimesEachclassisrepresented bykeypointscollection.

ThebenefitsofPart-Based Methodare:

- Difficulttonormalize withpreprocessingbutcharactersare recognizedwell

- Itisindependentofglobalstructure

- Itcanbeapplied tocursivescript

4) SlopeandSlantcorrectionmethod

In order to eliminate style variance, Meenu Mohan and his colleagues [6] devised a strategy. Based on the slope of the baseline, the text's slope may be determined using this approach. As a rule, ascenders and descenders are eliminated as soon as feasible throughout the creation process.

5) EnsembleMethod

In the field of machine learning, S. M. Shamim and his colleagues [10] created a novel classifier.

This technique automatically generates numerous classifiers from a single base class. Below, you will find an explanation:

- Method for Feature Search Ensmbles

- Algorithms for selecting features are available.

- The procedure of deciding which features to include in a product

6)

Zoning was done by P. Shankar Rao and his colleagues [11]. The picture processed is separated into zones, and feature extraction of the sign or letters is then performed.

Ithastwo methods:

a. StaticZone

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a) StaticZone

Zones of the picture are clearly defined here. At this point, the zones are permanently established. Without any previous knowledge of feature extraction or distribution, this is accomplished with no guidance. Zoning may be

done using data from experiments or the developer's long-term experience.

b) DynamicZone:

Non-uniform zones appear in the processed picture. It is possible to dynamically resize the photos in this section by dividing them into several zones. It also does not stay the same throughout time. It is decided how big a zone should be by looking at the neighboring ones. Resizing a zone may be used anytime more space is needed to accommodate new zones that have been identified.

### 3. Conclusion

To recognize handwriting, there are a variety of methods to choose from. One may find semi-incremental segmentation, convolutional neural networks, incremental zoning, and slope and slant

correction among these techniques. CNNs have the greatest accuracy, whereas Slope and Slant Correction has the lowest accuracy out of all of these approaches. Handwriting recognition with CNN is one of the most effective methods. The major drawback to this approach is that the model's training time is excessively long due to the large number of picture samples used. When using the Zoning technique, accuracy suffers when the number of zones created after splitting the input picture is too low. One of the main drawbacks of this approach is that the segmentation process will be difficult for developers, although this approach is too simplistic for handwriting detection.

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