

Handwriting Text Recognition using CNN

¹Mohammad Yusuf Khan, ²Meghana PG, ³Mahesh Bharti, ⁴Kanaiya V Kanzaria,
⁵Kalpesh Mohanta

⁵Senior Assistance Professor

^{1,2,3,4,5}School of Computing and Information Technology, REVA University, Bengaluru, India

¹askyusuf.khan@gmail.com, ²meghanapg3@gmail.com, ³maheshbharti3234@gmail.com,

⁴kanaiyavk@reva.edu.in, ⁵kalpeshmohanta@gmail.com

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Abstract

Handwritten Text Recognition (HTR) is demanding research in the area of Image processing. Presently numerous recognition techniques are well-known for recognition of handwritten English characters. The impact on handwriting can be seen in most of the modern computer and communication technologies like fax machines, word processors and email, etc. Throughout this survey, converting a language appointed in its abstraction kind of graphical representation to symbolic representation is taken into account as handwriting recognition. The initial and the most important stages for building any handwritten recognition system are pre-processing, segmentation and feature extraction. Handwriting is challenging to recognize due to differences in size and shape of the alphabets of the language, angle of handwritten text. A variety of recognition technologies for handwritten English alphabets are conferred here.

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1. Introduction

The impact on handwriting can be seen in most of the modern inventions in the computer and communication technologies such as fax machines, word processors and email, etc. The process of converting a language presented in graphical form into a symbolic presentation is considered as handwriting recognition. Transforming a large number of documents, either printed or handwritten into machine-encoded text, is the main aim of optical recognition (OCR) systems. As we all know that each person has his writing style, hence it is laborious to recognize the correct handwritten characters and digits. The handwritten text recognition system can be classified into two categories

- Online character recognition.

When characters are under creation, then recognition is performed.

- Offline character recognition.

Recognition is performed after handwritten documents are generated, scanned.

HTR System makes use of the following steps:

- Pre-processing
- Segmentation.

- Feature extraction.
- Training and recognition.
- Post-processing.

Several models are used for handwritten text recognition. Some of them are Artificial Neural Network (ANN), Convolutional Neural Network (CNN), Hidden Markov Model (HMM), Recurrent Neural Network (RNN), Long Short-Term Memory Model (LSTM), etc. In this study, we are making a dataset for the English alphabets. We are segmenting a sentence into words and then to the letters by using computer vision. The alphabet is fed to the model, which is trained to classify the input image to an English alphabet.

2. Objective

To obtain information about by customers using the documents provided. These documents are usually handwritten. For easier retrieval, data is converted and stored in digital formats. It can be arduous and time-consuming to process these documents manually. Therefore, a special HTR plays a crucial role in recognizing the image from documents and converting it to digital text and made easy by HTR Software. HTR has

many applications in different sectors like Banking sectors, Education, Health care, and many other organizations where handwritten documents are used very often. HTR systems are also used in various applications in the newly emerging industry where handwriting data entry is required.

3. Structure of HTR System

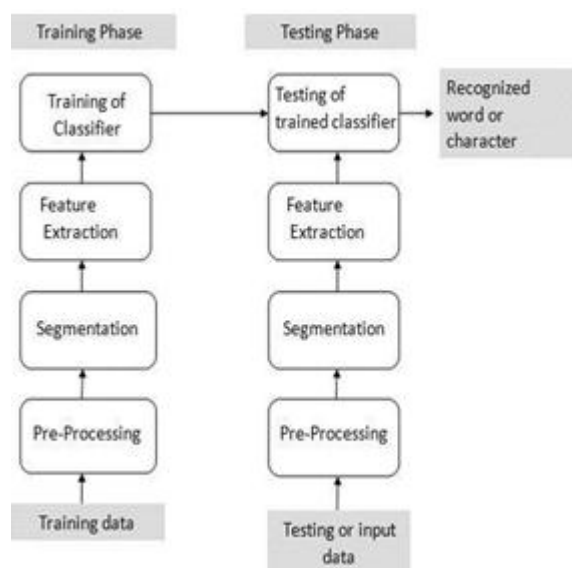


Figure 1: Diagram of the HTR System

The dataset is divided into two parts:

1. Training dataset
2. Testing dataset

A. Pre-processing

This stage consists of a series of operations performed carried out on the input image. It is used to enhance the quality of the image to make it fit for further process. The different techniques performed on the image within the pre-processing stage are as follows

- Noise removal

It is a technique of removing or reducing the noise from the input image using an acceptable feature.

- Binarization

The process of converting the Grayscale image to black and white by using Adaptive Gaussian Thresholding.

- Skew correction

It is the process of removal of skew within the scanned document image for correct segmentation. Skew correction methods are performed so that perfect horizontally aligned handwritten documents are acquired.

B. Segmentation

In this stage, the input images are fragmented into the sub- images of individual characters. It includes:

- line segmentation: paragraph ->line

- Word segmentation: line ->word
- Character segmentation: word ->characters

C. Feature Extraction

This stage consists of the extraction of features of characters that are important at the recognition stage. This is a crucial stage as its successful operation will improve the accuracy of recognition characters and reduces errors. Feature extraction:

- Statistical features

A statistical distribution of an image pixel of a handwritten text image that takes care of different writing styles. A statistical distribution of points derives Statistical features.

For example, crossings, distances, Projections, histograms, etc. The diagrams of the statistical features in figure 2

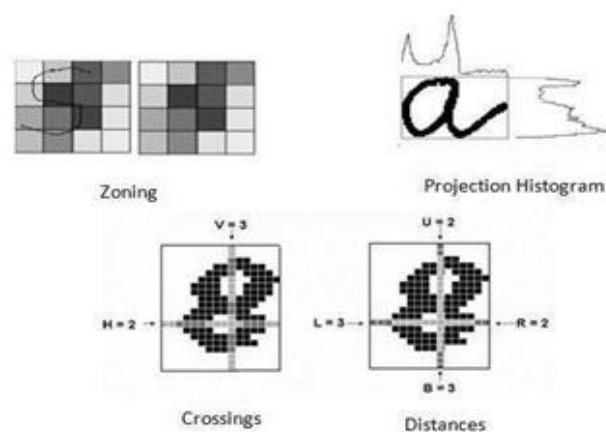
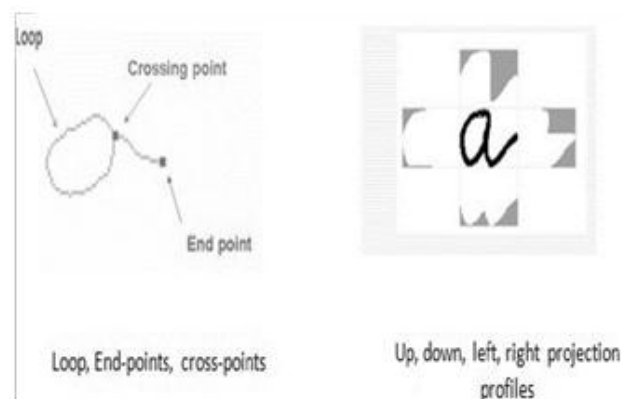


Figure 2: Statistical Feature

- Structural features

Structural features tell about the topological properties and geometrical properties of character, like loops, branches, stroke length, left and right projection profiles, etc.



The diagram of the structural feature in figure 3.

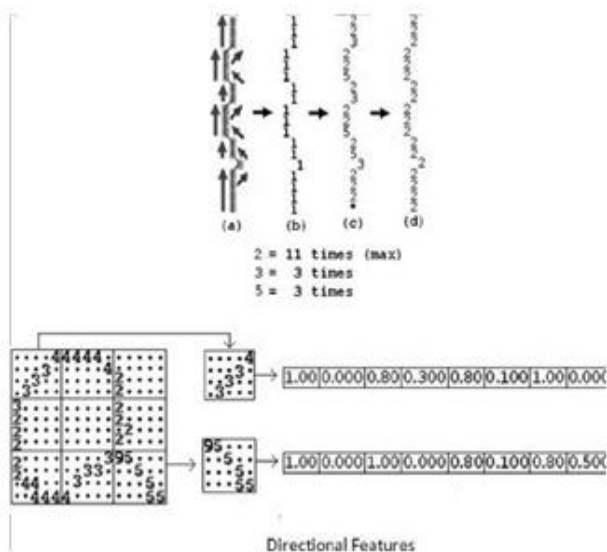


Figure 3: Structural features

D. Classification

This stage is a crucial stage of recognizing the characters which were segmented in the segmentation stage. For an accurate classification of characters, we have trained our model on the EMNIST dataset using the Convolution Neural Network (CNN).

- Convolution Neural Network

The advancement in the field of Computer Vision and Deep Learning has emerged with a new technique called Convolution Neural Network. CNN is analogous to Neural Network and are made up of perceptron having learnable parameters. CNN takes an image as input to find some distinguishable features and store them to Pooling Layer.

CNN is widely used for image classification, Video As compared to other classification algorithms like Support Vector Machine, Decision Tree, Logistic Regression, etc., the pre-processing required on CNN is much less. The architecture of CNN is similar to biological neurons.

Figure 4 shows the sequence of the Convolution and Pooling layer,

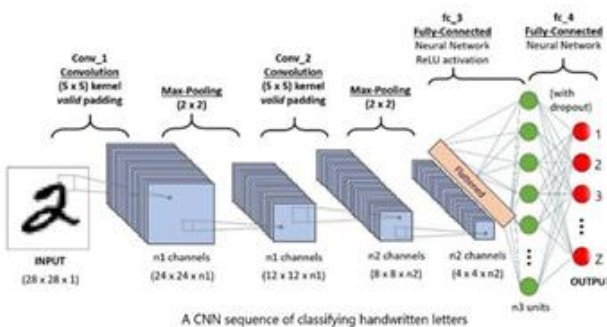


Figure 4: The sequence of the Convolution and Pooling layer

E. Post-Processing

This stage is used to increase the accuracy of the model by connecting a wordbook to the HTR system for both Semantic and Syntax analysis.

4. Literature Survey

HaradhanChel,et-al2011[1],In this paper, the neural network provides reliable performance in HTR, but it mostly depends on factors like training time, samples, etc. To obtain the fastest intelligence, the proper algorithm should be used by reducing time. In this paper, we deal with a second-order algorithm to achieve the most rapid test efficiency. There are three methods of implementation

1. Image preparation and segmentation: In this text is scanned using an optical scanner and stored, which converts into a binary image. By choosing a proper threshold, the image doesn't get discontinuity.
2. Features extraction: character is resized in a proper size.
3. Training of a Neutral Network: In this, it uses both single and multilayer forward network. The result of inadequate training because of the error curve, using a Hessian matrix of error equation, provide particular iteration in the error curve.

KatrienDepuydt and Jesse de Does 2015[2] Text line segmentation is a method by which image is extracted from the text line. There are many methods of text line segmentation has been seen in the paper. There are three methods of precision output

1. Perfectly fitted polygon: which surrounds each line. The error detection is corrected manually.
2. Simpler approach polygon: In this pixel above and below of polyline is taken.
3. Simplest rectangle: In this rectangle, automatically created around baseline by received some pixel. To less prone to error, manually errors are corrected.

HidetoOda, Akihito Kitadai 2016[3].In this, it searches keywords in a lattice composed of character. This technique reduces noise from output efficiently. There are four implementations

1. Segmentation of HTR: The text line has its line direction, which is character orientated and independent.
2. Segmentation of text line into a pattern: In this splitting of text line to obtained pattern elements.
3. Candidate lattices: In this, nodes represent character patterns, and each path shows sequences of segmentation.
4. Optimum recognition: It calculates the score of every way in a lattice. By generating lattice by the online pattern, it reduces noises and computation time.

Markus Wienecke, Gernot A. Fink, Gerhard Sagerer 2010 [4] In this paper, all text is pre proposed by the recognition module. Features use like extraction status modeling, etc. Recognition based on the Hidden Markov model (HMM) is conducted in independent mode and also in multi and single nodes for comparison. Recognition is achieved on word-based and character levels using a lexicon. Accuracy is improved by applying

statistical language models and in multiple writer mode performed by allograph character models.

Kamil R. Aida-Zade and Jamaladdin Z. Hasanov 2009 [5] Handwritten recognition (HWR) is most complicated by structure and function in HWR, thickness shape, accuracy varies from writer to writer, and also different manner used by the writer, which makes it's more complicated and hand impact on the efficiency of recognition.

There are two types

1. Online recognition: -deal with real-time data processing
2. Offline recognition: -based on static input of data and pixel information for recognition of each word.

Additional to this, cursive recognition is also essential. The approach was made to detect the text baseline in handwritten text recognition. This approach solved the problems of specific slant before this, ascending and descending parts separate top and bottom border lines are founds. This was the most precise approach. This is used for reducing manual text input time so that most time can be consumed in error correction.

P. Shankar Rao, J. Aditya [6] In this paper, to extract the features and to assign the observed character into the appropriate class pattern recognition algorithm has been used. Intending to attain the process of feature extraction to achieve the excellent and high performance of word recognition. Here they have used the HMM, Dynamic programming to arrive at the precise and proper result for the handwritten recognition in offline approach. The major drawback or the limitation in this paper is some words were unable to be trained since they belonged to all vast unknown lexicon. But this paper successfully comes up with handwriting recognition, especially for the hand-printed characters and words.

FlávioBortolozzi et-al [7] In this paper, advances in handwritten recognition have been discussed. Along with the character, recognition digits have also been recognized by various authors. In addition to this difficulty in the identification of cursive handwritten characters, numerical string, etc. is mentioned in this paper. The use of different models for the handwritten recognition mentioned in this paper is HMM (Hidden Markov Model), K-Nearest-Neighbor (K- NN), Neutral network (NN), etc.

J.Pradeep, E.Srinivasan and S.Himavathi [8] In this paper, for handwritten recognition author, has made the use of a neural network(NN). There are two types in handwritten recognition they are off-line handwritten recognition. The author of this paper has implemented off-line handwritten recognition. The diagonal tube extraction scheme has been proposed in this paper for been submitted in this paper for the off-line handwritten character recognition purpose. Matlab 7.1 is used for the implementation of a recognition system vertical, and the horizontal features extraction method is used to train a neural network recognition system. The author has mentioned that with the improved quality in the rate of

recognition in the off-line handwritten recognition system will be of great help in the applications such as bank processing, post address recognition, reading of documents, etc.

U.-V. Marti and H. Bunke [9] Handwritten Sentence Recognition is a system which first read segmented characters then aims at the recognition of cursively written words. In this system, complete handwritten lines of text are treated as input. The particular words we get after segmentation are a by-product of recognition. This system works on Hidden Markov models (HMMs).

The statistical language model was used to increase the performance of recognizer; hence it was considered as a fiction feature of this system. The function is used to increase the results of recognition and recognize individual words in a line of text. Hence, this system considers a complete text as a basic unit and several models, such as the unigram and bigram model used to increase performances. In the future, this system has a more refined language model, and more terminology will be considered.

U, -V. Marti and H. Bunke [10], In this author, represent a system that recognizes unlimited English handwritten text, which is mainly based on large vocabulary.

The very first step of this system is a segmentation of handwritten text into lines. Further, these segmented text lines are separated into a single word. During this, the distance between connected words is measured. Hence segmentation more considerable distance is preferred here over the threshold.

The second step follow is feature extraction. Every single word is represented as an image, a sequence of feature extracted comes up.

The third step is recognition. The above sequence formed becomes the input of the recognition procedure.

Since every single word is included as input, it complicates recognition procedure and becomes a complex task so to improve the result of recognition procedure, and multiple classifier combination is used. Here segmentation comes out as a byproduct of this system.

U.-V. Marti and H. Bunke [11], In this paper author, uses Lancaster-Oslo/Bergen (LOB) corpus. It includes text that was used to produce forms. A few pre-processing text segmentation procedures are also included. The main idea for this database is lingual knowledge as well Mexican level. It has become a necessary part of this research because of development, assessment, and to distinguish between different character recognition technique. Lingual knowledge was successfully applied, which defines only a possible sentence of the language. A few images processing procedures are also involved in extracting the handwritten text from the segmentation of text into lines and words. It serves as a basic unit for research in handwritten recognition. It provides automatic labeling of the database that further was also included in the Recognition

system.

5. Conclusion

Work and analysis have been done at an advanced level in the field of handwritten text recognition. However, full accuracy isn't achieved until now, that provides a scope of more work in this direction. The individual text provides high accuracy; however, it's affected by the different styles of writing. The holistic technique eliminates entangled segmentation; however, but they use restricted vocabulary. Techniques that use segmentation give less accuracy. High accuracy is within the classifier, wherever the words are limited, and it has to deal only with the limited number of variations. We tend to need an efficient solution to resolve this issue, thus overall performance is commonly amplified.

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