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# Handwritten character recognition using ANN- A Survey

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**Abstract:** *These days character recognition has gained lot of attention in the field of pattern recognition due to its application in various fields. Optical Character Recognition (OCR) and Handwritten Character Recognition (HCR) has specific domain to apply. For the applications like multi choice examinations, printed postal address resolution etc. OCR system is most suitable. Application of HCR is wider compare to OCR. In cheque processing in banks; almost all kind of form processing systems, handwritten postal address resolution and many more HCR is useful. In the near future, character recognition system might serve as a key factor to create paperless environment by digitizing and processing existing paper documents. In this paper, we have provided the detail study on existing methods for handwritten character recognition.*

**Keywords:** OCR, HCR, Features, Training, classification

## 1. INTRODUCTION

Handwritten Character Recognition has been an active area of research in the field of image processing in recent years due to the challenges faced during recognition process as the process incurs high uncertainty in the input documents because writing styles may vary abruptly depending on the interpersonal and intrapersonal variations. In various applications including data entry, office automation, digital library, banking applications, health insurance and tax forms etc. Optical Character Recognition can improve the interaction between man and machine. Much of work has been done in the recognition of machine printed characters in various languages with considerably good efficiencies, however making robust recognition engines that can be put to recognize hand written and hand printed data with commendable recognition rates still remains as an active area of research owing to the challenges like diverse human handwritten style, variation in shape, angle and style of characters. Therefore, it stands out to be a challenging task to devise and Optical Recognition System for handwritten document image.

A computer system recognizing characters and other symbols written by hand in natural handwriting is the process of Handwritten Character Recognition. The technology is used for identification. After this the computer turns the handwritten text into digital text. In general, handwritten recognition is of two types. They are off-line and on-line handwriting recognition methods. In the off-line recognition, the writing is captured optically by a scanner and the full text is available as an image so it contains no temporal data. Some existing techniques are fusion based segmentation method. In this approach, over segmentation of words from text based on pixel density between upper and lower based line with multiple expert base validation for character recognition and classification has been developed.

Slant and skew errors are neglected in this approach. In the on-line system successive points of the two dimensional coordinate are represented as a function of time. Here, the order of strokes made by the writer is also available. So, more challenges would be present while recognizing documents in the offline mode as we have only static information about the document. However, in the off-line system, the neural networks have been used to yield high recognition accuracy levels. Several applications including mail sorting, bank processing, document reading and postal address recognition requires off-line handwriting recognition. It continues to be an active area for research towards the exploring of newer techniques that would help to improve recognition accuracy.

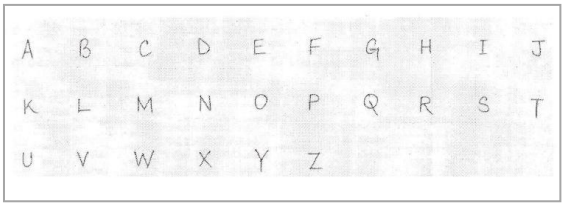


Fig. 1 Sample image of scanned handwritten characters

## 2. Working Principle for a general HCR

It can be divided into three parts Pre-processing, Feature Extraction, Classification with Neural Network.

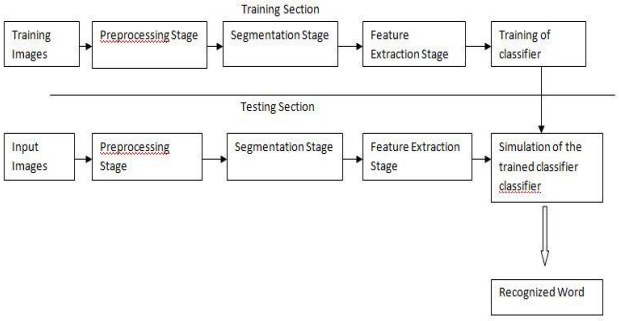


Fig. 2 Architecture of the model

### 2.1 Pre-processing

**Image Acquisition: -** Initially an image is captured by the scanner. Then the AC signal is converted into a digital signal that is transmitted to a computer for further processing.

**Image binarization: -** A handwritten document where the text is written by a single pen in input image has more or less the same intensity value. This value degrades if we use multiple pens. Assuming that the input image is having black foreground pixels and white background pixels then we reverse it for the other way round.

**Noise Removal:** Some common noise removal techniques are:

- Gabor Filter: In image processing, a Gabor filter, named after Dennis Gabor, is a linear filter which is used for detection of edges. Frequency and orientation representations of Gabor filters are same as those of the human visual system, and they have been found to be appropriate for texture representation and for texture discrimination.
- Median Filter: Median filtering is a common image enhancement technique used for removing salt and pepper noise. As the filtering is less sensitive than linear techniques to extreme changes in pixel values, it can be used to remove salt and pepper noise without reducing the sharpness of the image.
- Salt and Pepper Noise: It is a form of noise sometimes seen on images. It is generally sparsely occurring white and black pixels.

### 2.2 Line Segmentation

In this step, assuming that lines are relatively horizontal they are segmented from paragraph. As in paper [2] line segmentation involves the following steps:

1) A horizontal histogram is made for the binarized image
2) Proper minima's and maxima's of histogram are detected with median filter as smoothing function.

1D median filter can be used for smoothing. The median filter is an effective method which suppresses isolated noise without blurring sharp edges. The median filter replaces a pixel by the median of all pixels in the neighbourhood as explained below in equation:

$$Y[n,m] = \{\text{median}(x[i,j],(i,j) \in q)\}$$

Where q represents a neighbourhood centered around location (n,m) in the image.

3) Cuts are made at significant minima. A minima of 0 value signifies that there exists no intersecting ascender and descenders.
4) If there is an intersection at minima lines on either side of the cut, it is further analyzed for connected component. Further, centroid(C) of the connected component (CC) is found to classify whether it is ascender or descender. Three cases for CC are identified
   $Cut[i-1] + D \leq CC \leq Cut[i] - D \in$ current

<Cut[i-1] + D ∈previous
Else ∈ next

where threshold (D) is $\frac{1}{8}$ part of the difference of current minima and previous minima.

**Skew Correction: -** It is the concept of orthogonal projection with respect to x-axis. With un-skewed or normal text line or word image the orthogonal projection of the word image is always maximum.

**Edge Detection: -** This technique is used for finding the boundaries of objects within images. It detects discontinuities in brightness. Edge detection is used for image segmentation and data extraction in handwritten character recognition. An edge in an image is a boundary at which a significant change occurs in some physical aspect of the image, e.g. as the surface reflectance, illumination of the visible surfaces from the viewer. Changes in physical aspects manifest themselves in a variety of ways. It include changes in intensity, colour, and texture. Edge detection is needed for image segmentation.

**Character Segmentation and Recognition: -** A letter cannot be segmented before it is recognized and cannot be recognized before it is segmented. So segmentation and recognition work parallel with each other. In the segmentation stage, an image of each word received from the previous step is made to decompose into sub-images of individual characters.

Characters can be segmented by two approaches:

- Heuristic based segmentation - In this approach, stroke width and height are analyzed to segment words into its characters. Then character segmentation region is identified that compute the segmentation boundaries between the connected characters.
- Neural network approach – Here, Artificial Neural Network is trained for character recognition. For both training and testing phases, prospective segmentation points in handwritten words is located.

### 2.3 Feature Extraction

The features of characters that are crucial for classifying them at recognition stage are extracted in this step. It is an important step because its effective functioning improves the recognition rate. It also reduces misclassification.

**System Training and Testing: -** After the extraction of individual characters, the recognition engine identifies the corresponding computer character. Neural network recognizers learn from an initial image training set. The trained network then helps identify characters. Neural networks uniquely learn the properties that differentiate training images. To set up Neural Networks are quick. They also can be inaccurate if they learn properties that are not important in the target data.

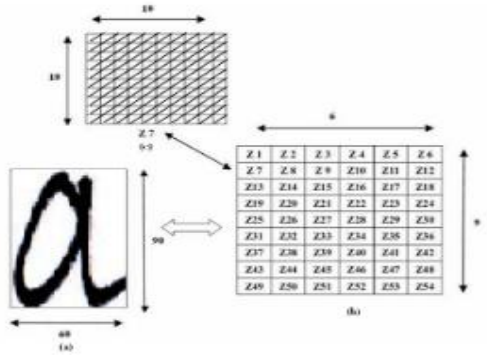

Fig 3. Procedure for extracting feature from the characters

### 2.4 Creating an Artificial Neural Network

The input is given through the network which traverses through each neuron as it compares the input image with each neuron and then gives the value in terms of a percentage of similarity .The neuron with highest percentage of similarity to the input image is considered. It can be estimated as the most favourable output which is most likely to that input.

## 3. Artificial Neural Network based approaches

The origins of automatic recognition of handwritten characters date back to 1940s. Rapid development has been observed in 1980s and early 1990s, mostly due to the progress in powerful computing hardware and image acquisition devices. An excellent survey of handwritten CR techniques can be found [1]. Reorganization of characters is an important area of research due to various applications in the modern world. Character recognition is very vast field. The paper [2] focus on use of Artificial Neural Network (ANN) to recognize Handwritten English characters. Character recognition is the earliest application of neural networking. This paper uses three parts image processing, feature extraction & neural networking. ANN is used to train the network using back propagation algorithm. An off-line handwritten alphabetical character recognition system using multilayer feed forward neural network is described in the paper [3].

Neural network is a computing paradigm which is loosely modelled after cortical structures of the brain. A neural network is sometimes used to refer to a branch of computational science that uses neural networks as models to simulate or analyze complex phenomena and/or study their principles of operation analytically. ANNs, learn by example. An ANN is configured for a specific application, through a learning process such as pattern recognition or data classification.

Some of the existing literature is presented in Table 1. The most commonly used networks consist of an input layer, a single hidden layer and an output layer. The number of hidden layer neurons requires to be experimented with the best results. More hidden layers increases complexity of system & very less hidden layers will cause errors in accuracy and.

## 4. CONCLUSION

Despite the computational complexity involved artificial neural networks offer several advantages in character recognition because neural network systems can work with noisy and defected data. Since training set images are same, systems can correctly and easily classify them. As handwritten character shapes and sizes varies from person to person, this causes misclassification of characters and decreases the recognition rate. We can increase the rate by changing network topology and collecting data with less noise. It is not possible to design fully automated system which can handle all kind of variability. Handwritten character recognition is still a burning research area of pattern recognition and lot of improvements are to be made by adding new features to the system.

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Table 1 Comparative analysis of previous papers

| PAPER | DESCRIPTION |
|---|---|
| Handwritten Text Recognition System Based on Neural Network [2] | • A novel approach has been proposed for handwriting recognition system involving segmentation for pre-processing steps and using diagonal based feature extraction technique with neural network for character recognition.<br>• Further, a diagonal based feature extraction technique is used for extracting the features of handwritten alphabets. Here, a character is segmented into parts dynamically for character recognition from the text, which improves the accuracy significantly.<br>• A feed forward artificial neural network is being use d for character classification, which also helps in deciding the threshold value for the character separation from the running text word. |
| Diagonal based feature extraction for handwritten alphabets recognition system using neural network. [3] | An off-line handwritten alphabetical character recognition system using multilayer feed forward neural network is described in the paper. A new method, called diagonal based feature extraction is introduced for extracting the features of the handwritten alphabets. |
| Introduction to multi-layer feed-forward neural networks. [5] | This paper introduced the basic concept for wavelet Transform, and some applications of Wavelet Transform used in HCR . It also discussed difference between conventional Fourier and modern time-frequency analysis. |
| Document image skew detection: Survey and | • Algorithms that estimate the angle at which a document image is rotated are surveyed. Four broad classes of technique are |

| | |
|---|---|
| annotated bibliography[6] | identified.<br>• These include methods that calculate skew from a horizontal projection profile, a distribution of feature locations, a Hough transform, or the distribution of responses from local, directionally sensitive masks. |
| Character Recognition Using Neural Network. [7] | In the present paper, neural network has been used to recognize the character. In this paper an off-line strategies has been developed for the isolated handwritten English character (A to Z). |
| Scale space Technique for word segmentation in Handwritten Document. [8] | In this paper it has developed a novel methodology for segmenting handwritten document images by analyzing the extent of "blobs" in a scale space representation of the image. |
| A Simple and Efficient Skew Detection Algorithm via Text Row Algorithm. [9] | This paper presents a new, accurate and robust skew detection algorithm based on a method for finding rows of text in page images. |

## BIOGRAPHY

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