Review on Neural Network Based Approach Towards English Handwritten Alphanumeric Characters Recognition

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Abstract— Handwritten Character recognition is one of the active and challenging areas of research in the intense field of Image Processing and Pattern recognition. It has large number of applications which includes, processing of bank cheques, reading aid for blind, conversion of any hand written document into digital form and many more. The main reason behind the activeness of the field are the challenges like the variation and distortion of handwritten characters, different style of writing and also the variety of scripts available across the entire world. This paper provides a brief review of the systems which implements various methodologies to recognize handwritten English characters.

Keywords/Index Term— Character recognition, Image Processing, Pattern recognition, Handwritten Character Recognition .

I. Introduction

Handwritten Character Recognition has gained immense popularity as it has wide application areas which reduce the task of data entry and save the time in case of Form filling, Postal Automation, and Banking etc. Development of a system that recognizes handwritten character is a challenging job due to the varying shape and size of the character, different writing styles of the character and many other factors. Researchers are now focusing on new techniques and methods that would reduce the processing time and at the same time would provide higher recognition accuracy. Character recognition plays vital role where there is large quantity of text based information. This area is mainly the electronic translation of handwritten, typewritten or printed text into machine editable form. Character recognition is also referred as optical character recognition (OCR). From the given image of characters as input, OCR deals in recognizing the character. In general the character recognition is basically classified into two types: Offline handwritten text recognition, online handwritten text recognition.

The process of Character Recognition is depicted in the figure 1. These phases can be applied to scanned document for text recognition.
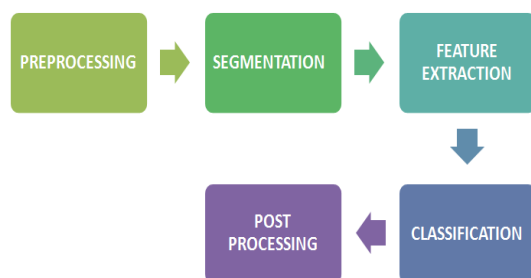

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Figure 1. Process of Character Recognition

A] PRE-PROCESSING PHASE

This phase is applied on the image so as to acquire the image suitable for the segmentation phase. It involves various steps like

- Removal of noise
- Resizing the image
- Skew Detection
- Binarization of the image etc.

Noise can be introduced in an image during image acquisition and transmission. There are different types of noise as Gaussian noise, gamma noise, Rayleigh noise, exponential noise, uniform noise, salt and pepper noise, periodic noise etc. Noise can be removed using ideal filters, Butterworth filters and Gaussian filters. Various skew detection techniques are projection profiles, connected components, Hough transform, clustering etc. Binary image can be achieved using Adaptive Thresholding, global Thresholding, variable Thresholding, Otsu's method etc[3].

B] SEGEMENTATION PHASE

This phase is considered to be the most important phase as the final output of the entire process depends upon the output of this phase. This step includes decomposition of the image in hierarchical way. It first divides the image into rows by applying row histogram, and then recognizes words by applying column histogram and then finally the characters are recognized from the words. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image.

There is great variety in segmentation techniques in the literature. This includes methods like Thresholding, Clustering methods, Compression-based methods, Histogram-based methods, Edge-detection, Region-growing methods, Split-and-merge methods etc [3].

I] Edge Detection Method: This method performs image segmentation by detecting the edges or pixels between different regions. The pixels that have rapid transition in intensity are extracted. After successful extraction, they are linked to form closed object boundaries. The output obtained is called binary image [11].There are two main types of edge based segmentation methods

    i) Gray histogram Method.
    ii) Gradient based Method.

II] Thresholding Method : Segmentation of image using Thresholding is an easy task. This method gives better results for the images that have light objects on dark background. This technique converts a multilevel image into a binary image. It works as follows; Choose a proper threshold value T. Using T, divide image pixels into several region and separate objects from background. Any pixel (x, y) is considered as a part of object if its intensity is greater than or equal to threshold value i.e., $f(x, y) \geq T$, else pixel belong to background.

According to the threshold value selected, only two types of Thresholding methods come in existence, Global and Local thresholding. When T is constant, the approach is called global Thresholding otherwise it is called local Thresholding. Only drawback of this method is that, it generates only two classes , and it cannot be applied to multichannel images. In addition, it ignores the spatial characteristics of an image due to this it is sensitive to noise.

III] Region Based Segmentation Methods: Segmentation algorithms based on region are simple and more immune to noise . These methods partition an image into regions that are similar according to a set of predefined criteria. Segmentation algorithms based on region mainly include Region Growing and Region Splitting and Merging method [11].

    Despite of large number of methods being available, there is not a single method which can be considered good for different images , since all methods are not equally good for a particular type of image[11] .

C] FEATURE EXTRACTION PHASE

Feature extraction is finding the set of parameters that define the shape of a character precisely and uniquely. This step is the key phase for any pattern recognition application. This step aims at extraction of the important features of the objects which can be used to distinguish it from the other

objects. The aim of this phase is to minimize the within class variation and maximize the between class variation so that the object can be uniquely recognized.

Feature extraction methods are classified into three major groups as:
• Statistical features.
• Global transformation and series expansion.
• Geometric and topological features. [2]

Various Feature extraction techniques like Principle Component Analysis (PCA), Linear Discriminant Analysis (LDA), Independent Component Analysis (ICA), Chain Code (CC), Scale Invariant Feature Extraction (SIFT), zoning, Gradient based features and Histogram may be applied to extract the features of individual characters. The feature vector so obtained as an output of this phase represents the characteristics of the object to be identified and is used to train the system.

D] CLASSIFICATION AND POST –PROCESSING PHASE

The classification is the process of identifying each character and assigning to it the correct character class. The classification techniques [2] can be categorized as:

• Classical techniques.
• Soft computing techniques.

The various classical techniques are Template matching, Statistical techniques, Structural techniques. Whereas the various soft computing techniques are Neural networks, Fuzzy logic, Evolutionary computing techniques.

The feature vector is given as an input to this important phase. This step classifies the vector on the basis of various classifiers. Most commonly used trained classifiers are Artificial Neural Network or Support Vector Machine. The classifiers compare the given vector with the stored pattern and give the best match as an output.

II. LITERATURE REVIEW AND RELATED WORK

Sandeep Saha and et.al obtained the image with very high resolution. So, it was necessary to crop the image to obtain the required image without disturbing the aspect ratio. After the cropping process of the image, it was converted into gray image. In this process, they converted a three dimensional 64*64*3 into a two dimensional image 64*64. They used morphological tool of Matlab platform to obtain skeleton of the character. In the feature extraction process, they first divided the whole image into 16 zones from zone 1-zone 16. Then the image was divided diagonally starting from left to right to obtain zone 17-zone 19. Similarly, the image was divided diagonally from right to left to obtain zone 20–zone 22. The image was then divided from bottom to top and top to bottom to obtain zone 23- zone 25 and zone 26-zone 28 respectively. The remaining zones were

obtained by combining the centre cells. After the extraction process, the corresponding vectors formed were feed into multilayer feed forward neural network and tested. The efficiency of using this method was 83.54%. The following figure 2 shows the entire process of feature extraction [1].
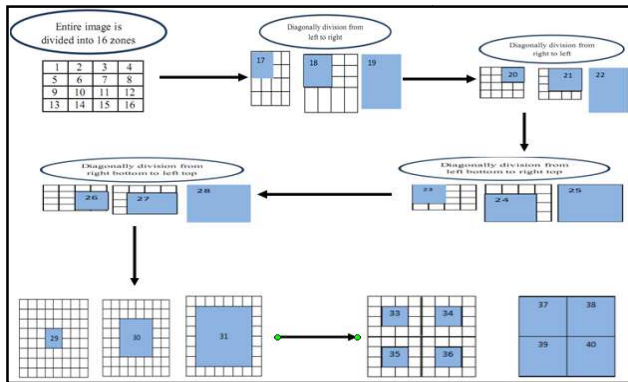

Figure 2: Process of 40 point feature extraction.

Apash Roy and N. R. Manna in their paper presented new approach for segmentation called Block-wise Segmentation Technique. In this technique, the image was divided into a 20 x20 matrix. This matrix consisted of 400 elements. This matrix was then divided into 25 small matrix of size 4 x 4. From these 25 small matrices, 25 vectors were formed and were fed as input to neural network for recognition. The results obtained were satisfactory [3]. The figure shows the process of BST
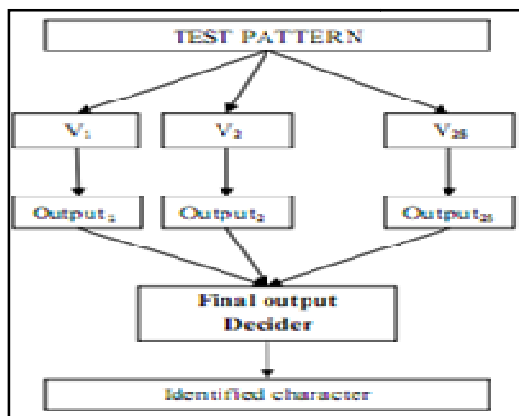

Figure 3:Character recognition with BST [3].

Tirtharaj Dash and Tanistha Nayak implemented charcater recognition system based on artificial neural network in C language. The neural network used was a single layer output neuron which showed whehter the character belonged to some cluster or not. They designed a simple ANN which took input through the input layer, applied some weight to it and the output layer gave the output. The result obtained after training of 10 training set was 93 % [6].

Md Fazlul Kader and Kaushik Deb proposed a neural-network based size and color invariant character recognition system using feed-forward neural network. This neural network had only two layers : input layer and output layer. The whole recognition process was divided into four basic steps such as pre-processing, normalization, network establishment and recognition. Pre-processing involved digitization, noise removal and boundary detection. After boundary detection, the input character matrix was normalized into 12×8 matrix for size invariant recognition and fed into the proposed network which consisted of 96 input and 36 output neurons. Then the trained network gave 99.99% accuracy only for numeric digits (0~9), 98% accuracy only for letters (A~Z) and more than 94% accuracy for alphanumeric characters by considering inter-class similarity measurement [10].

Yusuf Perwej and Ashish Chaturvedi developed a system that recognized hand-written English alphabets. In this system, each English alphabet was represented by binary values that were used as input to a simple feature extraction system, whose output was fed to neural network system.The system first arranged the character in 25 grid format. From this segmentd grid, digitized format of the character is obtained and then this digitised vector is fed to neural network for recognition.Experimental results showed that the machine successfully recognized the alphabets with th average accuracy of 82.5%, which significant and may be acceptable in some applications [12].

J.Pradeepa, E. Srinivasana, and S. Himavathi presented an off-line handwritten alphabetical character recognition system using multilayer feed forward neural network. They proposed a new method called diagonal based feature extraction for extracting the features of the handwritten alphabets. The procedure included dividing every character image of size 90x 60 pixels into 54 equal zones. The features were extracted from each zone pixels by moving along the diagonals of its respective 10X10 pixels. Each zone had 19 diagonal lines, thus 19 sub-features are obtained from the each zone. These 19 sub-features values were aggregated to form a single feature value and placed in the corresponding zone. This procedure was sequentially repeated for all the zones. There could be some zones. The feature values corresponding to these zones whose diagonals are empty of foreground pixels, were set to zero. Finally, 54 features are extracted for each character. In addition, 9 and 6 features were obtained by averaging the values placed in zones row-wise and column-wise, respectively. As a result, every character was represented by 69 features, i.e. 54 +15 features. The structure of neural network included an input layer with 54/69 inputs, two hidden layers each with 100 neurons and an output layer with 26 neurons. The gradient descent back propagation method with momentum and adaptive learning rate and log-

sigmoid transfer functions were used for neural network training. This diagonal method of feature extraction yielded highest recognition accuracy of 97.8 % for 54 features and 98.5% for 69 features [13].

III .CONCLUSION

The major approaches used in the field of handwritten Character recognition during the last few years have been reviewed in this paper. Different pre-processing, Segmentation, feature extraction, classification techniques are also discussed. Although, there is wide availability of methods for recognition of hand written English Alphanumeric characters have been proposed, lot of remarkable research is needed so that a viable solution can be made available. The existing OCR system for handwritten character recognition has satisfactory accuracy. There is a need for an efficient solution to solve this problem so that overall performance can be increased.

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