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NEURAL BASED OFFLINE HANDWRITTEN CHARACTER RECOGNITION

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Abstract— **Nowadays handwriting recognition is a most engrossing and demanding subject under which the research is still going on from several decades in the field of image processing and pattern recognition. Therefore we choose Neural network as a fast and reliable tools for classification towards achieving high recognition of character in our system. so this paper depicts some of the results concerned with the field of neural based Offline handwritten character recognition using neural network. This paper is concerned with the field of Offline handwritten Pattern Recognition which is a process where the computer understands automatically the image of handwritten script.**

I. INTRODUCTION

Recognition of handwritten character is one of the most captivating topics in pattern recognition.Handwriting recognition is the ability of a computer to receive and interpret intelligible handwritten input from sources such as paper documents, photographs, touch-screens and other devices.

In general, handwriting recognition is classified into two types as **off-line** and **on-line** handwriting recognition methods. The image of the written text may be sensed "off line" from a piece of paper by optical scanning (optical character recognition) or intelligent word recognition. Alternatively, the movements of the pen tip may be sensed "on line", for example by a pen-based computer screen surface. As a result, the off-line handwriting recognition continues to be an active area for research towards exploring the newer techniques that would improve recognition.

Off-line handwriting recognition involves automatic conversion of text into an image into letter codes which are usable within computer and text-processing applications. The data obtained by this form is regarded as a static representation of handwriting. On-line handwriting recognition involves the automatic conversion of text as it is written on a special digitizer or PDA, where a sensor picks up the pen-tip movements as well as pen-up/pen-down switching. This kind of data is known as digital ink and can be regarded as a digital representation of handwriting. The obtained signal is converted into letter codes which are usable within computer and text-processing applications. successive points are represented as a function of time and the order of strokes made by the writer are also available. The on-line methods have been shown to be superior to their off-line counter parts in recognizing handwritten characters due to the temporal information available with the former .

However, in the off-line systems, the neural networks have been successfully used to achieve comparably high recognition accuracy levels.

So,as a result neural based Off-line handwriting recognition is comparatively difficult, as different people have different handwriting styles. Several applications including mail sorting, bank processing, document reading and postal address recognition require offline handwriting recognition systems. Pattern recognition has three main steps: observ ation, pattern segmentation, and pattern classification.

II. OPTICAL CHARACTER RECOGNITION

It is really a challenging issue to develop a practical handwritten character recognition (CR) system which can maintain high recognition accuracy,that is optical character recognition(OCR) system.

Optical Character Recognition (OCR)) is a field of research in pattern recognition, artificial intelligence and machine vision. This is usually referred to as an off-line character recognition.It is a system that provides a full alphanumeric recognition of printed or handwritten characters at electronic speed by simply scanning the form.This involves photo scanning of the text character-by-character,analysis of the scanned-in image and then translation of the character image into character codes, such as ASCII,commonly used in data processing.It aims at transforming large amount of documents, either printed or handwritten into machine encoded text. OCR consists of many phases such as Pre-processing, Segmentation, Feature Extraction, Classifications and Recognition. The input of one step is the output of next step as shown in the fig 1.

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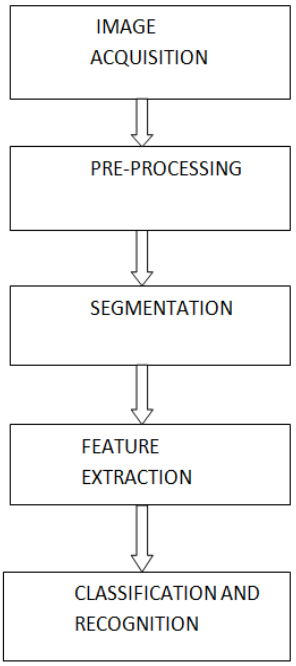

Fig.stages in OCR

a.

III. STAGES OF OPTICAL CHARACTER RECOGNITION SYSTEM

The Research in this field basically involves the following activities:-

3.1 Image Acquisition

This is the first step in the process to acquire handwritten.In this phase the input image taken through camera or some scanner. The image should have a specific format such as JPEG; BMT etc. The input captured may be in gray, color or binary from scanner or digital camera.

Figure 2: Sample Dataset

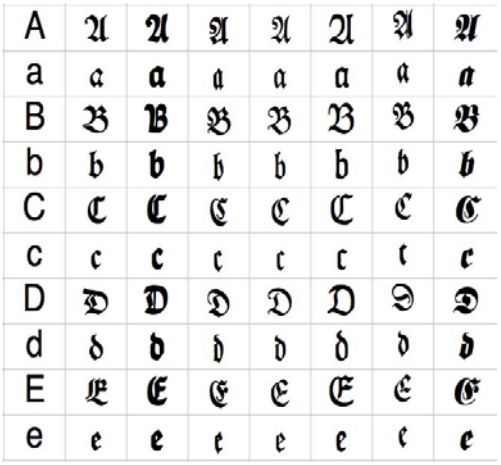

Figure 2: Sample Dataset

3.2 Pre-processing

The goal of preprocessing is to increase the quality of recognition, that means more precisely that character is transformed to such that they are more similar to the class they belongs. Basically in this phase a series of operations are performed on the scanned input image. It essentially enhances the image rendering it suitable for segmentation . The task of preprocessing relates to the removal of noise and variation in handwritten word patterns.The various tasks performed on the image in pre-processing stage are shown in Fig.1.
In this stage no any recognition process is performing. There is important interaction between preprocessing of character images and feature extraction process. In preprocessing the preliminary step is digitization or binarization.

3.2.1 Digitization/Binarization

In digitization object is converted into binary form by binarization method. Object is separated from background (1-represent as a region, 0 represent as a no region). This binarized image is put though preprocessing routines that smooth the image and eliminate noise, artificial holes and other artifacts produced by the digitizing process.Binarization process converts a gray scale image into a binary image. . Good binarization facilitates segmentation and recognition of characters.

3.2.2 Noise Reduction

When the document is scanned, the scanned images might be contaminated by additive noise and these low quality images will affect the next step of document processing. Therefore, a

pre-processing step is required to improve the quality of images before sending them to subsequent stages of document processing. Due to the noise there can be the disconnected line segment , large gaps between the lines etc. so it is very essential to remove all of these errors so that's the information can be retrieved in the best way.

There are many kinds of noise in images. One additive noise called "Salt and Pepper Noise", the black points and white points sprinkled all over an image, typically looks like salt and pepper, which can be found in almost all documents.

Noise reduction techniques can be categorized in two major groups as filtering, morphological operations.
(a) Filtering:
It aims to remove noise and diminish spurious points, usually introduced by uneven writing surface and/or poor sampling rate of the data acquisition device. Various spatial and frequency domain filters can be designed for this purpose [10].
(b) Morphological Operations
Morphological operations are commonly used as a tool in image processing for extracting image components that are useful in the representation and description of region shape. Morphological operations can be successfully used to remove the noise on the document images due to low quality of paper and ink, as well as erratic hand movement.

3.3 Segmentation

In Character Recognition techniques, the Segmentation is an important phase, because the extent to which one can reach in separation of words, lines or characters would directly affects the recognition system.
Segmentation is done to make the separation between the individual characters of an image. Segmentation of unconstrained handwritten word into different zones (upper middle and lower) and characters is more difficult than that of printed documents. This is mainly because of variability in inter-character distance, skew, slant, size and curved like handwriting. Sometimes components of two consecutive characters may be touched or overlapped and this situation complicates the segmentation task greatly. In Indian languages such touching or overlapping occurs frequently because of modified characters of upper-zone and lower-zone. There are two types of segmentation:

3.3.1 External Segmentation

External segmentation decomposes the page layout into its logical units. External segmentation is the isolation of various writing units, such as paragraphs, sentences or words. It is the most critical part of document analysis. Document Analysis and Recognition (DAR) aims at the automatic extraction of information presented on paper and initially addressed to human comprehension. Segmenting the document image into text and non-text regions is an integral part of the OCR software. Therefore, one who works in the CR field should have a general overview for document analysis techniques. Page segmentation is one important step in layout analysis and is particularly difficult when dealing with complex layouts

3.3.2 Internal Segmentation

Internal Segmentation is an operation that seeks to decompose an image of a sequence of characters into sub images of individual symbols. Although, the methods have developed remarkably in the last decade and a variety of techniques have emerged, segmentation of cursive script into letters is still an unsolved problem.

3.4 Feature Extraction

Features extraction plays a vital role in character recognition. The output of preprocessing is given to the feature extraction stage. Feature extraction is the process to retrieve the most important data from the raw data. The major goal of feature extraction is to extract a set of features, which maximizes the recognition rate with the least amount of elements. In feature extraction stage each character is represented as a feature vector, which becomes its identity. Due to the nature of handwriting with its high degree of variability and imprecision obtaining these features, is a difficult task. Feature extraction methods are based on 3 types of features- Statistical, Structural, Global transformations and moments. Structural and statistical features appear to be complementary in that they highlight different properties of the characters. The widely used feature extraction methods are Template matching, Deformable templates, Unitary Image transforms, Graph description, Projection Histograms.

3.5 Classification and Recognition

Classification is another one of the important stage for numeral character recognition. Having extracted the features, it is required to store them in some form. Each pattern should uniquely identify a character and each character may represent by several distinct pattern.So we can say that classification stage is the decision making part of a recognition system and it uses the features extracted in the previous stages. We summarize the classification methods in categories of statistical methods, artificial neural networks (ANNs), kernel methods, and multiple classifier com- bination. Character classifier can be Baye's classifier, nearest neighbor classifier, Radial basis function, Support Vector Machine, Neural Network etc. Numerous techniques for CR can be investigated in four general approaches of Pattern Recognition, as suggested in: Template Matching; Statistical Techniques; Structural Techniques; Neural Networks.

3.5.1 Template Matching

Optical Character Recognition by using Template Matching is a system prototype that is useful to recognize the character or alphabet by comparing two images of the alphabet. Template matching is the process of finding the location of a sub image called a template inside an image. Once a number of corresponding templates is found their centers are used as corresponding points to determine the registration parameters. Template matching involves determining similarities between a given template and windows of the same size in an image and identifying the window that produces the highest similarity measure .

3.5.2 Statistical methods

Statistical classifiers are rooted in the Bayes decision rule, and can be divided into parametric ones and non-parametric ones . Non-parametric methods, such as Parzen window and k-NN rule, are not practical for real-time applications since all training samples are stored and compared. The major statistical approaches, applied in the CR field are the followings:

a) Non-parametric Recognition
The finest known method of non-parametric categorization is the Nearest Neighbor (NN) and is widely used in CR. An incoming pattern is classified using the cluster, whose center is the minimum distance from the pattern over all the clusters. It does not involve a priori information about the data .

b) Parametric Recognition
Since a priori information is available about the characters in the training data, it is possible to obtain a parametric model for each character . Once the consideration of the model, which is based on some probabilities, is obtained, the characters are classify according to some decision rules such as Baye's method or maximum Likelihood.

3.5.3 Structural Techniques

Within the area of structural recognition, syntactic methods are among the most prevalent approaches. These patterns are used to describe and classify the characters in the CR systems. It involves syntactic methods that are the measures of similarity based on relationships between structural components may be formulated by using grammatical concepts. The idea is that each class has its own grammar defining the composition of the character. A grammar may be represented as strings or trees, and the structural component extracted from an unknown character is matched against the grammars of each class. Suppose that we have two different character classes which can be generated by the two grammars G1 and G2, respectively. Given an unknown character, we say that it is more similar to the first class if it may be generated by the grammar G1, but not by G2.

3.5.3.1 Neural network
As NN has parallel structure because of which it can perform computation at a higher rate than classical techniques. Therefore, we choose neural networks for character recognition in our system. The features that are used for training the neural network classifier also play a very important role. The choice of a good feature vector can significantly enhance the performance of a character classifier whereas a poor one may degrade its performance considerably. It is found in the literature that generally separate classifiers are used for the upper and the lower case English character classes to improve the recognition accuracy. Moreover, good recognition accuracy could be achieved only for handwritten numerals. In this paper, we focus on developing a CR system for recognition of handwritten English words. We first segment the words into individual characters and then represent these characters by features that have good discriminative abilities. We also explore different neural network classifiers to find the best classifier for the CR system. We combine different CR techniques in parallel so that recognition accuracy of the system can be improved.

An Artificial Neural Network as the backend is used for performing classification and Recognition tasks. In offline character recognition systems, the Neural Network has emerged as the fast and reliable tools for classification towards achieving high recognition. Neural network architectures can be classified into two major sets specifically; feed-forward and feedback (recurrent) networks and the majority common ANN used in the CR systems are the multilayer perceptron of the feed forward networks and the Kohonens Self Organizing Map (SOM) of the feedback networks, use Feed Forward Neural Network. In a feedforward neural network, nodes are organized into layers; each "stacked" on one another. The neural network consists of an input layer of nodes, one or more hidden layers, and an output layer . Each node in the layer has one corresponding node in the next layer, thus creating the stacking effect. Back propagation is a learning rule for the training of multi-layer feed-forward neural network. Back propagation derives its name from the technique of propagating the error in the network backward from the output layer. To train a Back propagation neural network, it must be exposed to a training data set and the answers or correct interpretations of the set .

The feed forward NN approach to the machine-printed CR problem is proven to be successful in , where the NN is trained with a database of 94 characters and tested in 300 000 characters generated by a postscript laser printer, with 12 common fonts in varying size. No errors were detected. In this study, Garland et al. propose a two-layer NN, trained by a centroid dithering process.

The modular NN architecture is used for unconstrained handwritten numeral recognition in . The whole classifier is composed of sub networks. A sub network, which contains three layers, is responsible for a class among ten classes.

IV. Conclusion

The detailed review has been discussed and hope that it is beneficial for further advances in the area.The accurate recognition is directly depending on the nature of the material to be read and by its quality. Current research is not directly concern to the characters, but also words and phrases, and even the complete documents. This paper depicts that selection of relevant feature extraction and classification technique plays an important role in performance of character recognition rate. This review establishes a complete system that converts scanned images of handwritten characters to text documents. This material serves as a guide and update for readers working in the Character Recognition area.

V. Future Work

There is still a need to do a lot of Research in this field for exploiting new features to improve the current performance. We can use some features specific to the mostly confusing characters, to increase the recognition rate. To recognize strings in the form of words or sentences segmentation phase play a major role for segmentation at character level and modifier level. So, there is still a need to do the research in the area of character recognition.

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