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Offline Handwritten Character Recognition With The Help Of Digital Dictionary

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Abstract: ***Handwriting recognition has been one of the active and challenging research areas in the field of image processing and pattern recognition. In this paper, the technique to increase the accuracy of recognition is suggested. It also involves the selection of Neural Networks and involved the use of Digital Dictionary. This use of Digital Dictionary will help the users to check with the dictionary for the availability of particular word and then display it if it is occurred. This helps to increase the accuracy in the recognition of characters.***

I. INTRODUCTION

Handwriting Character Recognition (HCR) has been challenging in research area in the field of image processing and pattern recognition. Several research works have been focusing on different methodologies in an attempt to reduce the processing time while simultaneously improving recognition accuracy .

In general, handwriting recognition can be classified into two major categories, namely off-line and on-line handwriting recognition methods.

Off-line handwriting recognition is comparatively a difficult task, as different people exhibit different handwriting styles. Handwriten Character Recognition (HWCR)/Image Character Recognition (ICR)engines have been primarily developed for recognizing machine printed and hand printed texts, while the recognition of handwritten documents entails special consideration as it involves recognizing the characters written with varying styles.

The steps in any handwritten recognition system are pre-processing followed by segmentation, feature extraction and classification. Pre-processing shapes the input image into a form suitable for segmentation. In the segmentation, the input image is segmented into individual characters and then, each character is resized into m x n pixels towards the training network. Segmentation includes external and internal segmentation. External segmentation decomposes page layout into logical units. while internal segmentation decomposes words into characters.

Feature extraction is a method widely used in pattern recognition. Feature extraction determines the important properties such as Aspect Ratio, Percent of pixels above horizontal half point, Percent of pixels to right of vertical half point, Number of strokes and Average distance from image center. This approach provides the recognizer more control over the properties used in identification. However, certain methods of modelling can incorporate both the feature extraction and classification stages together for simplifying the process of recognition. Such methods include the Hidden Markov models and Artificial Neural networks.

HMM suffer from intrinsic limitations, mainly due to their arbitrary parametric assumption. Artificial neural networks (ANNs) appear to be a promising alternative in this respect.

Neural network recognizers learn from an initial image training set. The trained network then performs the character identification. Each neural network uniquely learns the properties that differentiate training images. It then looks for similar properties in the target image to be identified. Neural networks are quick to setup; however, they can be inaccurate if the learning is incomplete or if the system has over learnt unimportant data in the target. Yet any system using this approach requires substantially less development time than a feature extraction based network or a HMM based method.

The artificial neural network as the backend for performing classification and recognition tasks using segmented images have been reported in literature. The architecture of the neural network to a large extent determines the capability for classification. The popular methods are Template matching, feed forward networks, nearest neighbourhood method and radial basis network. The methods reported in literature include single layer networks, multilayer networks and use of multiple neural network structures.

The proposed method optimizes the number of neurons in the hidden layer independent of the intial value. In this paper, an off-line handwritten character recognition system using neural networks that integrate both feature extraction and classification processes is investigated. Prior to segmentation, the pre-processed image is converted into binary image. The

binary image is segmented into individual characters and then, each character is resized into 30x20 pixels. Each resized character is classified and recognized using different neural classifiers. As the structure of the neural network determines the efficiency of the recognition system, this paper proposes the use of Feed Forward Network with back propagation. Also, the simplest technique, namely, template matching is used for comparison.

II. LITERATURE SURVEY

In this section, the survey taken for proposed recognition system is described. A typical handwriting recognition system consists of pre-processing, segmentation, feature extraction, classification and post processing stages. The general schematic diagram of the recognition system is shown in Fig.1.The proposed method in which both the feature extraction and classification processes together are preformed in a single stage is shown in Fig.2.In reference[2], it gets explained the various methods on recognition tried to implemented and their results. Resulting on all of these references, we proposed here to use a Neural Network with Back Propagation. The study involved in the reference is given below.

A] A system is developed using Hidden Markov Models, which gives accuracy of 88% for word recognition[3].
B] **Alceu de Britto** proposed a system with two stage Hidden Markov Models based method[4].
C] **Said** proposed a neural network with single hidden layer[5].
D] Multilayer feed forward networks were proposed by **Saleh Ali K and Al-Omari**[6]**.**

Based on these proposes, all neural networks were examined and present the most efficient network in that paper. The result proposes that the multilayer networks is highly recommended, because of its increased accuracy.

The general and the schematic diagram is depicted as follows.

Figure 1. General off-line character recognition system

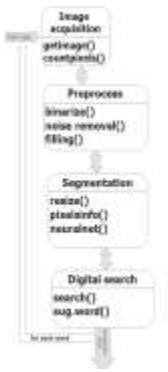

Figure 2. Schematic diagram of the proposed off-line recognition system

Image Acquisition In Image acquisition, the recognition system acquires a scanned image as an input image. The image should have a specific format such as JPEG, BMP etc. This image is acquired through a scanner, digital camera or any other suitable digital input device. Data samples for the experiment have been collected from different individuals. Samples of the collected handwritten English characters A to Z are shown in Fig.3.

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Figure 3. Samples of handwritten English characters A to Z

Pre-processing The pre-processing is a series of operations performed on the scanned input image. It essentially enhances the image, making it suitable for segmentation. The various tasks performed on the image in the pre-processing stage are shown in Fig. 4. Binarization process converts a gray scale image into a binary image using global thresholding technique. Detection of edges in the binarized image is done using sobel technique. Image dilation and filling of holes are performed in the last two stages to produce the preprocessed image suitable for segmentation .

Figure 4. Pre-processing of handwritten character of image

Segmentation In the segmentation stage, an image consisting of sequence of characters is decomposed into sub-images of individual character. In the proposed system, the preprocessed input image is segmented into isolated characters and each character is assigned a number using a labelling process. This labelling provides information about number of characters in the image. Each individual character is uniformly resized into 30X20 pixels for classification and recognition stage.

Feature Extraction The widely used feature extraction methods are Template matching, Deformable templates, Unitary Image transforms, Graph description, Projection Histograms, Contour profiles, Zoning, Geometric moment invariants, Zernike Moments, Spline curve approximation, Fourier descriptors, Gradient feature and Gabor features . Due to the nature of handwriting with its high degree of variability and imprecision extracting these features, is a difficult task.

This paper does not adopt any of the above stated methods for feature extraction. The binary image is segmented into individual characters and then, each character is resized into 30x20 pixels. Each resized character is subjected to the classification and recognition tasks. That is, each resized character has 600 pixels and these pixels are taken as feature inputs to the different classifiers.

Classification The classification stage is the decision making part of the recognition system. The 600 pixels derived from the resized character in the segmentation stage form the input to the classifier. In general the feature vector is denoted as X, and defined as $X = (f_1, f_2, \ldots, f_d)$, where f denotes features and d is the total number of pixels present in the each character. The number of input neurons is determined by length of the feature vector d. The total numbers of characters n determines the number of neurons in the output layer.

Digital Search In this process, the word obtained from the feature extraction process will be used. It uses searching algorithm for searching the occurrence of the word . Once the occurrence is searched, then the word gets saved to the database of words for saving the search time once it will get a chance for searching the same word.

If the word doesn't occur then error message will be shown. At that time write the correct spelling, and add the word to the dictionary for future purpose.

III. PROPOSED SYSTEM ARCHITECTURE

During the last few decades, the field of character recognition has received a major attention from research workers in diverse disciplines such as conversion of handwritten document to an editable soft format, recognition of postal addresses for automated postal system, data and word processing, data acquisition in bank checks and processing of archived institutional records. Some methods integrate the feature extraction and classification tasks. Such methods are simpler and easier to implement. In this paper such methods are studied and the accuracy achieved is reported.

3.1. Neural Network based classifier Neural Network (NN) techniques offer a promising solution as classifiers in the handwritten character recognition system. The image after resizing is taken as an input. The classification capability of the network depends on the architecture and learning rule. The architecture considered in this paper is feed forward architecture . It is followed by the reference paper wordings on how it obtain the samples and work on it. "To evaluate the performance of the proposed method the handwritten uppercase English alphabets were collected from different individual writers. Of the 7800 samples collected, 5200 samples were used for training purpose and remaining 2600 samples were used for testing. The proposed recognition system has been implemented using Matlab 7.1"[2]. The recognition system designed using Feed Forward Network method is listed below.

The feed forward network with two hidden layer is suggested in Figure 5.This network is containing multiple hidden layers with input and output layer. The output layer contains 26 layers for 26 alphabets and the input layer contains 600 layers for 30*20 pixels. The result obtained from the network after applying the samples and the parameters are shown in Figure 6 and Figure 7.

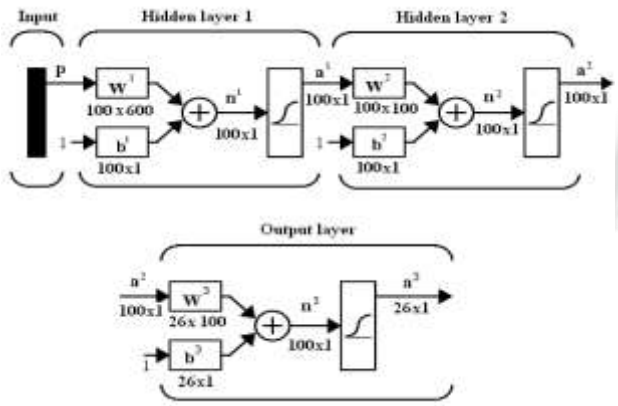

Figure 5. Two hidden layer neural network for character recognition

Figure 6. Feedforward Neural Network Training Parameters

Feedforward Neural Network parameters	
Input nodes	600
Hidden layers	2
Hidden layers nodes	100 each
Output nodes	26(alphabets)
Training epochs	50000
Training algorithm	Gradient descent with momentum training and adaptive learning
Performance function	Mean Square Error (MSE)
Training goal achieved	10e-8

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Figure 7. Summary of result achieved by proposed system

Classifier	No.of.alphabets with recognition rate greater than 90%	Alphabets with recognition rate greater than 90%
Feed Forward NN	23	A,B,C,F,G,I,J,K,L,M,N,O,P,Q,R,S,T,U,V,W,X,Y,Z

IV. RESULTS AND DISCUSSION

The results in Figure 7 indicate the superior recognition accuracy of Feedforward Neural network as compared to other classifiers. Using a number of handwritten test data the confusion matrix was obtained for the four different classifiers. This was to investigate the recognition accuracy for each alphabet. This parameter is important as any written text would have a varied number of each alphabet. If the classifier has more than 90% recognition rate for each alphabet then the overall worst case recognition rate would be almost constant irrespective of the data.

Figure 7 reports the number of alphabets having recognition rate less than 90% and the alphabets are also listed. It is seen from Figure 7 , Among the NN based classifiers the Feed forward neural network recognizes 23 alphabets with over 90% accuracy and is the best classifier.

The classification accuracy of the Feedforward NN is shown separately for each alphabet in Fig. 8. The maximum number of misclassification occurs for the letter D which is misclassified 16 times for every 100 presentations (84% recognition). All the other alphabets have better recognition accuracy.

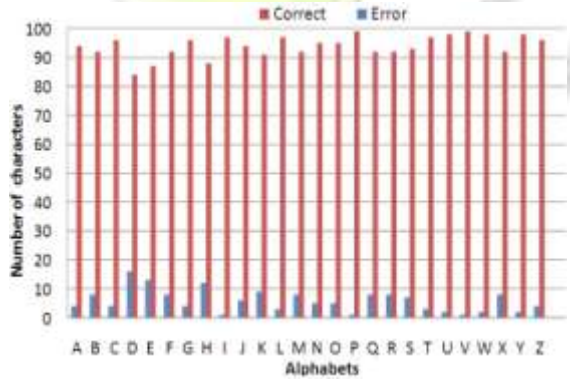

Figure 8. Performance illustration the correct & error individual alphabets for the Feed forward NN

V. CONCLUSION

An off-line handwritten character recognition system with namely, Feedforward NN for recognizing handwritten English alphabets has been described in this paper. The feature extraction and classification tasks are performed together as a single process and additional fature of digital search is added in the proposed system unlike in typical handwritten recognition systems in which these tasks are carried out in two different stages. As a result, the proposed system is found to be less complex and allows faster recognition of characters. Experimental results show that the feed forward neural network is distinctly superior to the other classifiers in recognizing the handwritten English alphabets. Further investigation was carried out to identify the recognition rates for each letter of alphabet. This would help to estimate the recognition rate irrespective of the handwritten content. It was identified that the Feedforward NN outperformed the remaining classifiers. The proposed system will find useful applications in recognizing the handwritten names, reading documents and conversion of any

handwritten document into structural text form. Further improvements may be possible with a more complex Feedforward NN architecture but this would also increase the computation complexity. Therefore, combination of a standard feature extraction technique with Feedforward NN and Digital Search technique may provide better solutions.

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