Feature Extraction based on Diagonal Direction for Handwritten Recognition System using Neural Network

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Abstract: An off-line handwritten character recognition system using multilayer feed forward neural network is described in the paper. A new method feature extraction based on diagonal directions is introduced for extracting the features of the handwritten characters. The proposed recognition system performs quite well yielding higher levels of recognition accuracy compared to the systems employing the conventional horizontal and vertical methods of feature extraction. This system will be suitable for converting handwritten documents into structural text form and recognizing handwritten names.

Keywords: Handwritten character recognition, Image processing, Feature extraction, feed forward neural networks.

I. INTRODUCTION

Handwriting recognition has been one of the most fascinating and challenging research areas in field of image processing and pattern recognition in the recent years [1] [2]. It contributes immensely to the advancement of an automation process and can improve the interface between man and machine in numerous applications. Several research works have been focusing on new techniques and methods that would reduce the processing time while providing higher recognition accuracy [3].

In general, handwriting recognition is classified into two types as off-line and on-line handwriting recognition methods. In the off-line recognition, the writing is usually captured optically by a scanner and the completed writing is available as an image. But, in the on-line system the two dimensional coordinates of 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 counterparts in recognizing handwritten characters due to the temporal information available with the former [4] [5]. However, in the off-line systems, the neural networks have been successfully used to yield comparably high recognition accuracy levels .Several applications including mail sorting, bank processing, document reading and postal address recognition require off-line handwriting recognition systems. 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 accuracy [6] [7].

The first important step in any handwritten recognition system is pre-processing followed by segmentation and feature extraction. Pre-processing includes the steps that are required to shape the input image into a form suitable for segmentation [8]. 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.

The Selection of appropriate feature extraction method is probably the single most important factor in achieving high recognition performance. Several methods of feature extraction for character recognition have been reported in the literature [9]. 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.

An artificial neural Network as the backend is used for performing classification and recognition tasks. In the off-line recognition system, the neural networks have emerged as the fast and reliable tools for classification towards achieving high recognition accuracy [10]. Classification techniques have been applied to handwritten character recognition since the 1990s. These methods include statistical methods based on Bayes decision rule, Artificial Neural Networks (ANNs), Kernel Methods including Support Vector Machines (SVM) and multiple classifier combination [11], [12].

U. Pal *et al*, have proposed a modified quadratic classifier based scheme to recognize the offline handwritten numerals of six popular Indian scripts [7]. Multilayer perceptron has been used for recognizing Handwritten English characters [13].The features are extracted from Boundary tracing and their Fourier Descriptors. Character is identified by analyzing its shape and comparing its features that distinguish each character. Also an analysis has been carried out to determine the number of hidden layer nodes to achieve high performance of back propagation network. A recognition accuracy of 94% has been reported for handwritten English characters with less training time.

Dinesh et al [14] have used horizontal/vertical strokes and end points as the potential features for recognition and reported a recognition accuracy of 90.50% for handwritten Kannada numerals. However, this method uses the thinning process which results in the loss of features.

U. Pal et al [15] have proposed zoning and directional chain code features and considered a feature vector of length 100 for handwritten numeral recognition and have reported a high level of recognition accuracy. However, the feature extraction process is complex and time consuming.

In this paper, a diagonal feature extraction scheme for the recognizing off-line handwritten characters is proposed. In the feature extraction process, resized individual character of size 90x 60 pixels is further divided into 54 equal zones, each of size 10x10 pixels. The features are extracted from the pixels of each zone by moving along their diagonals. This procedure is repeated for all the zones leading to extraction of 54 features for each character. These extracted features are used to train a feed forward back propagation neural network employed for performing classification and recognition tasks. Extensive simulation studies show that the recognition system using diagonal features provides good recognition accuracy while requiring less time for training.

The paper is organized as follows. In section 2, the proposed recognition system is presented. The feature extraction procedure adopted in the system is detailed in the section 3. Section 4 describes the classification and recognition using feed forward back propagation neural network. Section 5 presents the discussion about an idea. Finally, the paper is concluded in section 6.

II.   THE PROPOSED RECOGNITION SYSTEM

The proposed recognition system is described in this section. A typical handwriting recognition system consists of pre-processing, segmentation, feature extraction, classification and recognition, and post processing stages.

A. 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, BMT etc. This image is acquired through a scanner, digital camera or any other suitable digital input device.

B. Pre-processing

The pre-processing is a series of operations performed on the scanned input image. It essentially enhances the image rendering it suitable for segmentation. The various tasks performed on the image in pre-processing stage. Binarization process converts a gray scale image into a binary image using global thresholding technique. Detection of edges in the binarized image using sobel technique, dilation the image and filling the holes present in it are the operations performed in the last two stages to produce the pre-processed image suitable for segmentation [16].

C. Segmentation

In the segmentation stage, an image of sequence of characters is decomposed into sub-images of individual character. In the proposed system, the pre-processed input image is segmented into isolated characters by assigning a number to each character using a labeling process. This labeling provides information about number of characters in the image. Each individual character is uniformly resized into 90X60 pixels for classification and recognition stage.

III.   PROPOSED FEATURE EXTRACTION METHOD

In this stage, the features of the characters that are crucial for classifying them at recognition stage are extracted. This is an important stage as its effective functioning improves the recognition rate and reduces the misclassification [17]. Diagonal feature extraction scheme for recognizing off-line handwritten characters is proposed in this work.

IV.   CLASSIFICATION AND RECOGNITION

The classification stage is the decision making part of a recognition system and it uses the features extracted in the previous stage. A feed forward back propagation neural network having two hidden layers with architecture is used to perform the classification. The hidden layers use log sigmoid activation function, and the output layer is a competitive layer, as one of the characters is to be identified. The feature vector is denoted as X where $X = (f1, f2, fd)$ where f denotes features and d is the number of zones into which each character is divided. 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. The number of neurons in the hidden layers is obtained by trial and error. The most compact network is chosen and presented.

The network training parameters are:

_ Input nodes:
_ Hidden nodes:
_ Output nodes:
_ Training algorithm:
_ Perform function:
_ Training goal achieved:
_ Training epochs:
_ Training momentum constant:

V.   DISCUSSION ABOUT AN IDEA

The recognition system will be implemented using Matlab7.1.The scanned image is taken as   dataset/ input and feed forward architecture is used. The structure of neural network includes an input layer with two hidden layers and an output layer. The gradient descent back propagation method with momentum and adaptive learning rate and log-sigmoid

transfer functions is used for neural network training. A recognition system using two different feature lengths is built. The number of input nodes is chosen based on the number of features. After training the network, the recognition system will be tested using several unknown dataset and then the results will compare/obtained.

Two approaches with three different ways of feature extraction are used for character recognition in the proposed system. The three different ways of feature extraction are horizontal direction, vertical direction and diagonal direction. In the first approach, the feature vector size is chosen without row wise and column wise features. The criteria for choosing the type of feature extraction are: (I) the speed of convergence, i.e. number of epochs required to achieve the training goal and (ii) training stability. However, the most important parameter of interest is the accuracy of the recognition system. Study of Review results that the diagonal feature extraction yields good recognition accuracy compared to the others types of feature extraction.

VI.   CONCLUSION

A simple off-line handwritten characters recognition system using a feature extraction, namely, diagonal based feature extraction is proposed. This approach is chosen to build the Neural Network recognition system. To compare the recognition efficiency of the proposed method of feature extraction, the neural network recognition system is trained using the vertical and horizontal feature extraction methods. The diagonal method of feature extraction is verified using a number of test images. The proposed off-line hand written character recognition system with better-quality recognition rates will be eminently suitable for several applications including postal/parcel address recognition, bank processing, document reading and conversion of any handwritten document into structural text form.

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