ENGLISH HANDWRITTEN CHARACTER RECOGNITION

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Abstract— Handwriting recognition has gained a lot of attention in the field of pattern recognition and machine learning due to its application in various fields. Various techniques have been proposed for character recognition in handwriting recognition system like Surf method, Fuzzy logic and Optical Character Recognition (OCR). Among these OCR techniques is more compatible compared to other techniques. Handwritten character recognition is classified into two types as off-line and on-line handwriting recognition methods. In offline recognition, scanned image of the text is considered as input. But, in the online system input is given through touch pad. This paper describes about English Handwritten character recognition system which uses feature extraction based on gradient technique and artificial neural network for recognition.

Keywords—Handwritten Character Recognition, Optical Character Recognition, Neural Network.

I. INTRODUCTION

Currently people look for the work to be done in less and with high accuracy. Since last few decades and advancement in technology computers interact more effectively with human and with the natural world e.g, speech recognition, handwritten recognition, gesture recognition etc. In a curiosity to understand and uncover secret of how human can recognise patterns many efforts have been attempted in this area to mimic human behaviour. Handwritten character recgognition is one such area where "Handwriting" is to preserve information so as to retrieve at a later stage.

The development handwritten recognition begans in 1950's, when there were human operator whose job was to convert data from various documents into electronic format, making the process quiet long and often effected by errors automatic text recognition aims at limiting these error by using image processing techniques. That brings increased speed and precision to the entire recognition process.

Handwritten character recognition is an area of pattern recognition which defines an ability of a machine to analyse patterns and identify the character. Pattern recognition is the science of making inferences from perceptual data based on either a priori knowledge or an statistical information. The basic function of pattern recognition spans a number of scientific disciplines uniting them in the search for the solution to the common problem of recognizing the member of a class in a set containing elements from many patterns in classes. Handwritten character recognition is classified into two categories: online recognition in which text is written through touch pad and other is offline recognition where scanned images of the text are considered. This ability can be induced in machine using OCR (Optical Character Recognition) technique. OCR is the identification of both handwritten and printed document using computer [1].

In OCR technique, digital camera or a scanner is used to capture different types of documents like paper documents, PDF files and character images and convert all these documents into machine editable format like ASCII code[5].

Advantage of OCR systems is that it can reduce the data entry time, storage space required by documents. Fast retrieval is an alternative advantage. OCR can be used in diverse fields like banking field where checks can be processed without human interruption and to digitize paper documents in legal industries. This paper describes about English Handwritten character recognition system which uses feature extraction based on gradient technique and artificial neural network for recognition.

II. METHODOLOGY

Normally handwritten recognition is divided into 4 phases:

1. Pre-processing
2. Segmentation
3. Feature extraction
4. Recognition

The block diagram of the basic character recognition is shown in Figure 1.

A. Image Acquisition

Scanned Image is initially taken as input. The most common of these devices is the electronic tablet or digitizer. These devices use a pen that is digital in nature. Input images for handwritten characters can also be taken by using other methods such as scanners.

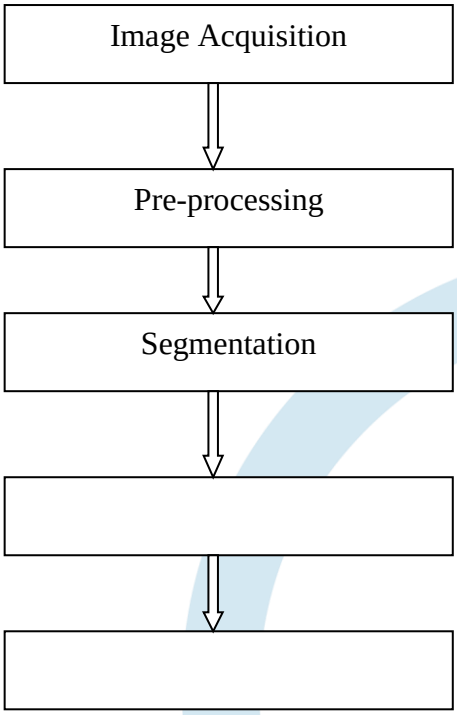

Figure 1 Block diagram of character recognition

B. Pre-processing

Pre-processing is the basic phase of character recognition and it's crucial for good recognition rate. The main objective of pre-processing steps is to normalize strokes and remove variations that would otherwise complicate recognition and reduce the recognition rate. Preprocessing is an important step in character recognition, which includes noise removal, binarization, skeletonization and normalization [9].

Noise removal

Noise is the unwanted intensity values in an image that has no significance in the output. Different types of noises such as impulse noise, gaussian noise, speckle noise and photon noise are added to the character image during image acquisition. Noise removal is the technique required to eliminate this unwanted bit patterns. Linear and non linear filtering can be used for noise removal. Median filter is a non linear filter very effective in removing salt and pepper noise, which is an impulse noise present in image as small black and white dots [9]. Median filter sort all the pixels in a particular area and replace the centre pixel with the median of sorted values.

Binarization

Process of converting color or gray scale image into bilevel image. Local and global thresholding is the method used for binarizing an image. In local thresholding different threshold values are chosen but for global thresholding a single value is used. Otsu is the global thresholding used which iteratively determine all possible threshold values and find out there variance. The optimal threshold is choosen in such a way that which has minimum interclass variance.

Image dilation

Image dilation is one of the basic operators in the area of mathematical morphology. The effect of this operator on a binary image is to gradually enlarged the boundaries of regions of foreground pixels.

Normalization

Process of converting image into some standard form. Normalization includes size and skew normalization. Size normalization converts image in to fixed size. Bilinear and bicubic interpolation can be used. Skew may introduce in the image at the time of scanning, which is the deviation of text from base line. To align this text skew detection and corrections are required.

C. Segmentation

In the segmentation stage, an image of sequence of characters is decomposed into sub-images of individual character. The pre-processed input image is segmented into isolated characters by assigning a number to each character using a labelling process. This labelling provides information about number of characters in the image. Each individual character is uniformly resized into pixels[9]. Normalization: After extracting the character, normalize the size of the characters because of large variations in the sizes of each Character hence need a method to normalize the size.

D. Feature Extraction

Feature extraction is the main phase in character recognition. Recognition accuracy is mainly depends on extracted features. The main aim of feature extraction phase is to extract that pattern which is most pertinent for classification. Different feature extraction methods described are Directional features [3], Gradient and curvature [4], Gradient alone is used as feature in [6], zonal feature [18][5], Count, position of horizontal and vertical intensity lines [10] and boundary tracing [7].

E. Character recognition

When input image is presented to system, its features are extracted and given as an input to the trained classifier like artificial neural network or support vector machine. Classifiers compare the input feature with stored pattern and find out the best matching class for input. Classification is the decision making stage of character recognition. The extracted features are used for recognizing characters. The classification of relevant features are done by using different classifier like neural network, SVM, KNN, Multilayer perceptron [14], Decision tree [15].

III. LITERATURE SURVEY

A few state of the art approaches that use hand written character recognition for text identification have been summarized here:

Chirag I Patel,Ripal Patel, Palak Patel,Objective of this paper is to recognize the characters in a given scanned documents and study the effects of changing the Models of ANN. The paper describes the behaviors of different Models of Neural Network used in OCR. OCR is widespread use of Neural Network. We have considered parameters like number of Hidden Layer, size of Hidden Layer and epochs. We have used Multilayer Feed Forward network with Back propagation. In Preprocessing we have applied some basic algorithms for segmentation of characters, normalizing of characters and De-skewing.

AshutoshAggarwal, Rajneesh Rani, RenuDhir: Feature extraction is an integral part of any recognition system. The aim of feature extraction is to describe the pattern by means of minimum number of features that are effective in discriminating pattern classes. The gradient measures the magnitude and direction of the greatest change in intensity in a small neighborhood of each pixel. Gradients are computed by means of the Sobel operator.Due to its logical simplicity, ease of use and high recognition rate, Gradient Features should be used for recognition purposes.

Kauleshwar Prasad, Devvrat C. Nigam, AshmikaLakhotiya and DheerenUmre: Recognition of Handwritten text has been one of the active and challenging areas of research in the field of image processing and pattern recognition. This paper focus on recognition of English alphabet in a given scanned text document with the help of Neural Networks. Using Mat lab Neural Network toolbox to recognize handwritten characters by projecting them on different sized grids. The first step is image acquisition the scanned image followed by noise filtering, smoothing and normalization of scanned image, rendering image suitable for segmentation where image is decomposed into sub images. Feature Extraction improves recognition. Character extraction and edge detection algorithm for training the neural network to classify and recognize the handwritten characters.

Dinesh Dileep: This paper describes a geometry based technique for feature extraction applicable to segmentation-based word recognition systems. The proposed system extracts the geometric features of the character contour. These features are based on the basic line types that form the character skeleton. The feature vectors so generated from a training set were then used to train a pattern recognition engine based on Neural Networks so that the system can be benchmarked.

IV. FEATURE EXTRACTION

There are two techniques employed based on the efficiencies obtained, while training the neural network. They are as follows:

- Feature Extraction based on Character Geometry.
- Feature Extraction Using Gradient Features.

Feature Extraction Based on Character Geometry.

It extracts different line types that form a particular character. It also concentrates on the positional features of the same. The feature extraction technique explained was tested using a Neural Network which was trained with the feature vectors obtained from the system proposed.

Feature extraction based on Character Geometry includes: Universe of Discourse, Zoning, Starters, Intersections and Minor Starters [9].

Feature extraction using Gradient Feature Extraction.

The gradient measures the magnitude and direction of the greatest change in intensity in a small neighbourhood of each pixel[4],[6]. (In what follows, "gradient" refers to both the gradient magnitude and direction). Gradients are computed by means of the Sobel operator. The Sobel templates used to compute the horizontal (X) & vertical (Y) components of the gradient are shown in Figure 2.

1	2	1
0	0	0
-1	-2	-1

-1	0	1
-2	0	2
-1	0	1

Horizontal Component Vertical Component

Figure 2: Sobel masks for Gradient

Given an input image of size D1×D2, each pixel neighbourhood is convolved with these templates to determine these X and Y components, Sx and Sy, respectively. Eq. (1) and (2) represents their mathematical representation:

$$S(i, j) = I(i-1, j+1) + 2 * I(i, j+1) + I(i+1, j+1) - I(i-1, j-1) - 2*I(i, j-1) - I(i+1, j-1). \quad (1)$$

$$S(i, j) = I(i-1, j-1) + 2* I(i-1, j) + I(i-1, j+1)\ y - I(i+1, j-1) - 2* I(i+1, j) - I(i+1, j+1) \quad (2)$$

Here, (i, j) range over the image rows (D1) and columns (D2), respectively. The gradient strength and direction can be computed from the gradient vector [Sx, Sy].
After obtaining gradient vector of each pixel, the gradient image is decomposed four orientation planes or eight direction planes (chain code directions) as shown in Figure 3.

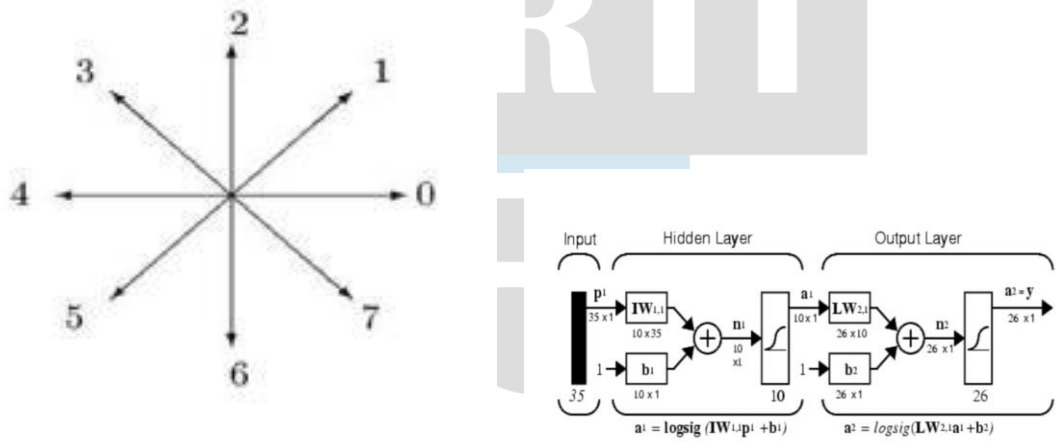

Figure 3: Directions of chain codes Generation of Gradient Feature Vector

A gradient feature vector is composed of the strength of gradient accumulated separately in different directions as described below[6]: (1) the direction of gradient detected as above is decomposed along 8 chain code directions. (2) The character image is divided into 81(9 horizontal × 9 vertical) blocks. The strength of the gradient is accumulated separately in each of 8 directions, in each block, to produce 81 local spectra of direction. (3) The spatial resolution is reduced from 9×9 to 5×5 by down sampling every two horizontal and every two vertical blocks with 5×5 Gaussian Filter to produce a feature vector of size 200 (5 horizontal, 5 vertical, 8 directional resolution). (5) The variable transformation (y = x0.4) is applied to make the distribution of the features Gaussian-like. The 5 × 5 Gaussian Filter used is the high cut filter to reduce the aliasing due to the down sampling.

V. ARTIFICIAL NEURAL NETWORK

Animals recognize various objects and make sense out of large amount of visual information, apparently requiring very little effort. Simulating the task performed by animals to recognize to the extent allowed by physical limitations will be enormously profitable for the system [2], [5], [7] and [10]. This necessitates study and simulation of Artificial Neural Network. In Neural Network, each node perform some simple computation and each connection conveys a signal from one node to another labelled by a number called the "connection strength" or weight indicating the extent to which signal is amplified or diminished by the connection.

Different choices for weight results in different functions are being evaluated by the network. If in a given network whose weight are initial random and given that we know the task to be accomplished by the network , a learning algorithm must be used to determine the values of the weight that will achieve the desired task [2]. Learning Algorithm qualifies the computing system to be called Artificial Neural Network. The node function was predetermined to apply specific function on inputs imposing a fundamental limitation on the capabilities of the network. Typical pattern recognition systems are designed using two pass. The first pass is a feature extractor that finds features within the data which are specific to the task being solved (e.g. finding bars of pixels within an image for character recognition). The second pass is the classifier, which is more general purpose and can be trained using a neural network and sample data sets. Clearly, the feature extractor typically requires the most design effort, since it usually must be hand-crafted based on what the application is trying to achieve.

Back propagation was created by generalizing the Widrow-Hoff learning rule to multiple-layer networks and nonlinear differentiable transfer functions. Input vectors and the corresponding target vectors are used to train a network until it can approximate a function, associate input vectors with specific output vectors, or classify input vectors in an appropriate way as defined. Networks with biases, a sigmoid layer, and a linear output layer are capable of approximating any function with a finite number of discontinuities.

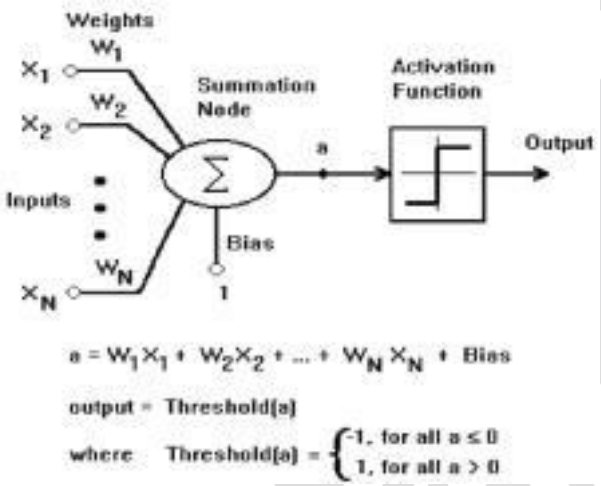

Figure 6: Typical Neural Network

Once the network is trained, the match pattern is obtained to generate the associated character. Output will be the beautified version of the uploaded image and will be saved in a .doc or in text file.

Figure 7: Block diagram of Neural Network

VI. CONCLUSION

The effectiveness of the method that uses feature extraction using gradient technique from scanned images containing handwritten characters is presented. The feature extraction methods have performed well in classification when fed to the neural network and preprocessing of image using edge detection and normalization are the ideal choice for degraded noisy images. The method of training neural network with extracted features from sample images of each character has detection accuracy to a greater extent. The proposed methodology has produced good results for images containing handwritten text written in different styles, different size and alignment with varying background. The system is developed in MATLAB and evaluated for a set of sample images containing handwritten text computer. The method is advantageous as it uses nine features to train the neural network using character geometry and twelve features using gradient technique.

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