Proceedings of the 4th WSEAS Int. Conf. on Information Security, Communications and Computers, Tenerife, Spain, December 16-18, 2005 (pp354-359)

Character Recognition with Histogram Band Analysis of Encoded String and Neural Network

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Abstract:-

This paper proposes a novel method of recognition of hand written character alphabets artificial neural networks together with conventional techniques. However in real situation it is not easy to build robust recognition because of vast variations in personal writing styles. There are also differences in one person's writing style depending on the context, mood of writer and writing situation. The proposed method solves the problem by combining image encoding, histogram of encoded strings and training of neural network with the same information. This technique can be divided into five major steps: 1) Digitization of image 2) Thinning of binary image using a parallel thinning algorithm 3) Segmentation of the image 4) Extraction of features by encoding image in string form and find relationship between the structure of one segment to the structure of previous segment 5) Histogram band analysis of encoded string 6) Training of neural network with the information extracted from histogram band analysis and classify as a particular character using feed forward neural network trained by back propagation

The authors have implemented a prototype system based upon the proposed method and conducted some experiments using the system. Experimental results support effectiveness of the proposed idea.

Key -words:- Handwritten character recognition, Histogram, Neural Network ,Back propagation.

1. Introduction

Machine simulation of human reading has been subject to intensive research for the last three decades. However, the early investigations were limited by the memory and power of the computer available at that time. With the explosion of information technology, there has been a dramatic increase of research in this field since the beginning of 1980's

Character extraction and recognition techniques have potential applications in any domain where a large mass of document image bearing texts must be interpreted.

Convent ally such images are processed like human operators who act according to what has been written or simply key in what they read onto computer system that carries out further processing, say of postal address. However, automation of entire process requires a high recognition rate, as well as maximum reliability. Research is going on to overcome the problems and bring simplicity.

Research areas in character recognition can be grouped into two main schemes namely: online and offline character recognition. In the former, the data are captured during the writing process by a special pen on an electronic surface. In the latter, the data are acquired by a scanner after the writing process is over [3][4][5][8]. In this case, the recognition of offline handwriting is more complex than online case due to the presence of noise in the image acquisition process and the loss of temporal information such as writing sequence and velocity. To date, few products are commercially available for autonomous recognition of printed text in a restricted number of fonts. It is well known that the computer recognition of hand-printed text is a difficult issue because of the writing style and the shape vary enormously.

Interest in neural network is rapidly growing and several neural network models have been proposed for various difficult problems, especially classification problems. Traditional classifiers test the competing hypothesis sequentially where as neural network classifiers test the competing hypothesis in parallel, this providing high computational rate .A number of worker have recently applied neural network techniques to hand printed character recognition by using statistical approach. However, these have generally been confined to relatively small character sets, usually digits only. This approach is usually more expensive and has proven very effective for large and complex sets.

In the project described in this paper, neural networks methodology has been applied only in the final classification step, the computational intensive earlier stages being done by more classical approaches. Thus this takes hybrid approach to character recognition.

2. Feature Extractor

In recent years, different methods are used for the recognition of handwritten characters. The method ,which used is to consider a region, which includes the letter. Letter is converted into image of 1's and 0's. After that thinning algorithm and noise reduction algorithms are applied. The processed image is used for feature extraction. The image is divided into segments of 1's and image is encoded according to the features: segment height, segment position, number of segments in one column and relationship between segments. Features are extracted in the form of string of characters.

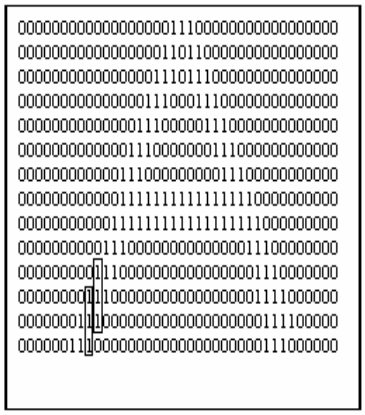

Fig. 1: Handwritten character 'A' converted into sequence of '0's and '1's

All possible types of relationship between segments are to be given one character code. Example character codes are shown for the following possible type of relationship between two segments.

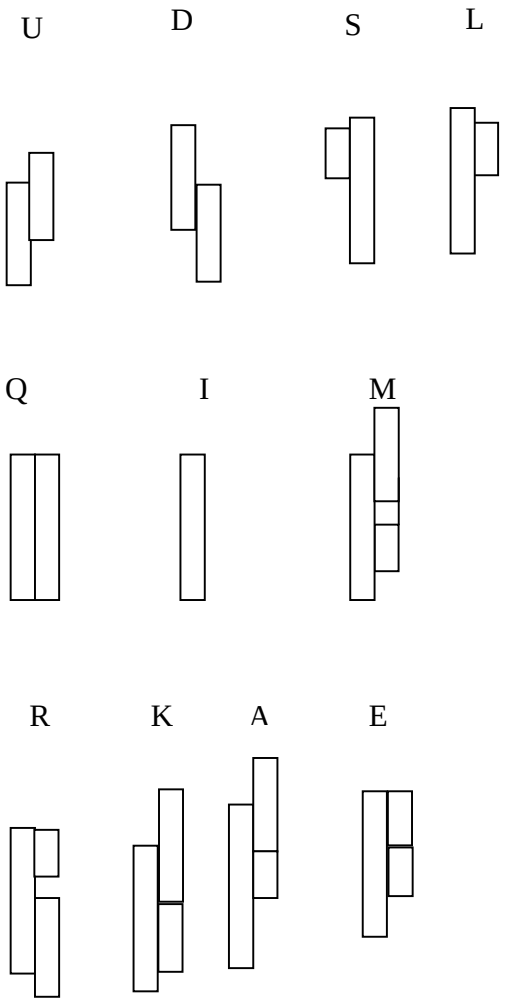

Fig. 2: Possible relationship between two segments given a character code

Relationship between two segments can be categorized according to above specified segment relationships and one character code is identified. In this way one string can be generated from one image of a handwritten character. The following are example string generated from hand written character 'A'

SSUSUUUUUUSSEUQUQUQLQLQLSDQ
DLDQDQDQDSLDDDDDDDDDDLL

SSSSUUSULUUUUEUSULUQLQLQDQD
QDQDQDQDQDQDQDQDQDSLDDDDD
DDDDLL

SSSUUUUUUUUUUSEUQUQUQUQUQ
LQLQLQDQDQDQDQDSDDDDDDDDDD
LL

SSSSUUUUUUUSEUQUQUQUQUQUQL
QLSDLDQDQDQDSDLDQDQDQDQDSL
DLDDDLDDDDDDDDDLDL

Histogram band information is extracted from the above string by keeping the sequence of characters. . The feature vector is extracted from four example histogram of encoded string of character of 'A' as described above.

S 2 U 1 S 1 U 6 S 2 E 1 U 1 Q 1 U 1 Q 1 U 1 Q 1 L 1 Q 1 L 1 Q 1 L 1 S 1 D 1 Q 1 D 1 L 1 D 1 Q 1 D 1 Q 1 D 1 Q 1 D 1 S 1 L 1 D 10 L 2;

S 4 U 2 S 1 U 1 L 1 U 4 E 1 U 1 S 1 U 1 L 1 U 1 Q 1 L 1 Q 1 L 1 Q 1 D 1 Q 1 D 1 Q 1 D 1 Q 1 D 1 Q 1 D 1 Q 1 D 1 Q 1 D 1 Q 1 D 1 Q 1 D 1 Q 1 D 1 Q 1 D 1 S 1 L 1 D 9 L 2;

S 3 U 11 S 1 E 1 U 1 Q 1 U 1 Q 1 U 1 Q 1 U 1 Q 1 U 1 Q 1 L 1 Q 1 L 1 Q 1 L 1 Q 1 D 1 Q 1 D 1 Q 1 D 1 Q 1 D 1 Q 1 D 1 Q 1 D 1 S 1 D 10 L 2;

S 4 U 7 S 1 E 1 U 1 Q 1 U 1 Q 1 U 1 Q 1 U 1 Q 1 U 1 Q 1 L 1 Q 1 L 1 S 1 D 1 L 1 D 1 Q 1 D 1 Q 1 D 1 Q 1 D 1 Q 1 D 1 S 1 L 1 D 1 L 1 D 3 L 1 D 9 L 1 D 1 L 1;

3. The Classifier

Artificial neural methods are used for achieving recognition rather than programming them. Multilayer Perception (MLP) neural networks is used for recognition. The MLP is in general, a layered feed-forward network that can be represented by a directed acyclic graph. Each node in the graph stands for an artificial neuron of the MLP, and the labels in each directed arc denote the strength of synaptic connection between two neurons and the direction of the signal flow in the MLP.

Neural network is trained by examples. Programmers need not give neural networks the qualitative description of objects being recognized and sets of logical criteria to distinguish such objects from similar objects. Instead of it examples of objects with their identification is sufficient. The network memorizes this information by modifying the values in its weight matrix and will produce correct response when the object is seen again [6]. This learning ability of neural networks made it appropriate for present problem. Rather than trying all possible variants, a reasonable approach is to take a large sample of actual handwritten characters (with their correct classifications) and apply a machine learning technique to devise a classification algorithm. Such methods include symbol processing-style algorithms and back propagation neural networks. As we are familiar with neural networks, we use this method .For pattern classification ,the number of neurons in the input layer of an MLP is determined by the number of features selected for representing the relevant patterns in the feature space and the output layer is determined by the number of classes in which the input data belongs.

If an image of one hand written character is of 100*100 pixels and the maximum length of encoded string that can be generated of 100 character long and band can be 200 information long.

S 2 U 1 S 1 U 6 S 2 E 1 U 1 Q 1 U 1 Q 1 U 1 Q 1 L 1 Q 1 L 1 Q 1 L 1 S 1 D 1 Q 1 D 1 L 1 D 1 Q 1 D 1 Q 1 D 1 Q 1 D 1 S 1 L 1 D 10 L 2

Designed neural network is trained with the histogram band information . Input to neural network cannot be a character , a character can be mapped to a number .

S →
2 →
U →
1 →
.
.
.
200

4. Experiments and results

The neural network model receives n inputs of n/2 character occurrences in encoded string and one neuron at output layer to identify an alphabet. The network is two-layer *log-sigmoid/purelin* network. The log-sigmoid transfer function is picked because its output range(0 to 1) is perfect for learning to output Boolean values and purelin for (1-26 values) output layer .

3-layer network is used with one output unit giving 26 values for each possible character, 200 neurons on hidden layer and 200 neurons at inputs. The overall network is shown in fig 3. Back propagation learning rate is set to suitable values based on the trial runs. The stopping criteria of BP algorithm selected for the present work is that the mean of the squared errors for all training patterns will be less than a certain limit. The neurons in hidden and output layers compute the *sigmoid* and *purelin* respectively functions on the sum of the products of input values and weight values of the corresponding connection to each neuron.

The hidden (first) layer has 200 neurons. This number was picked by guesswork and experience. If the network has trouble learning, then neurons can be added to this layer. All training is done using back

propagation with gradient descent with momentum and adaptive learning rate back propagation with the function *traingdx* with accuracy of .0001. The following number of samples as indicated in table 1 are used for training and get result with goal accuracy in approximately 2000 epochs. The following data is calculated with 5 samples of 4 characters for testing.

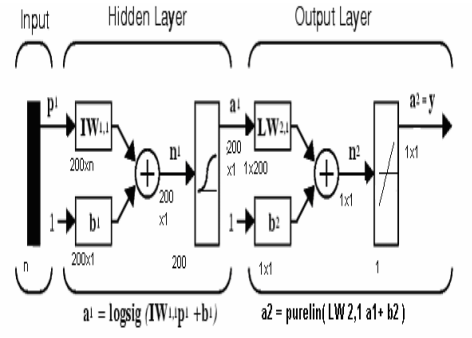

Fig. 3: Neural network for character recognition with one hidden layer

Output result of test patterns from neural network are used to calculate average relative error

Relative error= (Output value /True value of a character) x100

Average relative error=(sum of relative errors of all patterns for testing / number of patterns) x100

Some patterns correctly classified with 100 % accuracy and remaining number of patterns are classified with absolute relative error as indicated in table.

Some patterns deviate from actual value in positive direction and some deviate in negative direction, average relative error will cater to both and absolute average relative error is the average of absolute of all deviations. It is true error in the system.

Table 1: Relative error in system is decreasing with number of patterns for training increasing.

Number of patterns for training	Avg. relative error %	Avg. relative deviation in error %	Absolute avg. relative error %	Number of patterns identified with 100 % accuracy out of 20
40	8.9	22	16.89	08
60	1.4	13.6	13.36	09
80	2.7	12.6	12.20	11
100	1.27	7.63	7.61	14
120	1.98	6.62	6.80	16

5. Conclusion

A new approach for handwritten character recognition has been proposed. The experimental result confirms that proposed method results in high performance in terms of recognition rate and classification accuracy. Hence the developed architecture is robust in the recognition of handwritten characters.

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