AUTOMATIC HANDWRITTEN RECOGNITION FOR NOISY ENGLISH WORD USING NEURAL NETWORK

Rajesh Soni, Member, IEEE and Durga Puja, Member, ISTE
Department of Computer Science
BSA College of Engineering & Technology
Mathura, India
rajeshcsmt10@bsacet.org, durga.puja@bsacet.org

***Abstract*— Neural Network computing has been expected to play a significant role in a computer-based system of recognizing handwritten noisy English words. This is because a neural network can be trained quite readily to recognize several instances of a written letter or word, and then can be generalized to recognize other different instances of that same letter or word. This capability is vital to the realization of robust recognition of handwritten words or scripts, since words are rarely written twice in exactly the same form. This proposed work is done with five samples of hand written Characters of English alphabet collected from five different people and stored as an image. After partition these scanned images of noisy characters into 4 portions, the densities of these images are determined by using MATLAB function *Mean_character_recognition.m*. An input pattern will use these 4 densities of each character as an input for the neural network architecture. Global database is one which is used to map the Density values of handwritten English characters of input test pattern to density values of handwritten English character of target output pattern stored in global database. It is difficult to analyze the performance and to generalize the proposed methods because the global database that we are using here is little bit small. The small number of images of characters and their values are to be considering in database. Complexity increases on comparing the truth and false of an approach in absence of global database. So modeled global database is needed for testing and therefore we treat a representative modeled small database as a global database containing 130 character images and 546 records.**

Global database is the main part of the proposed handwritten word recognition system that is used for storing the character images of different test inputs and different target outputs for pattern mapping. Different target outputs store in global database map their patterns to final output that come from MATLAB and then desired target output is match with the different-different test inputs store in global database and the matched characters will go through post processing and the collection of characters that is the word is to be recognized.

Keywords—Neural Network; Character Recognition; Handwritten Word Recognition; Pattern Recognition.

I. INTRODUCTION

There is a fundamental property of recognition for all mankind, a person collects all information when he or she firstly look at an object and match and check its class, identity and behavior with past knowledge stored in mind. If we get a proper match, we recognize it [1]. This concept of recognition is simple in the real world environment, but in the world of computer science, recognizing an object is an amazing feat. The Human brain is god gifted miracle, there is no comparison of any machines or software with it.

Pattern recognition is the process of categorization of input data into identifiable classes through the extraction of significant attributes of the data from irrelevant background detail. Some common attributes determine a pattern class category So a pattern is the description of a category member representing a pattern class. Thus, a pattern class is a family of patterns that shares some common properties. The aim of pattern recognition is to classify the data or patterns based on either a priori knowledge or on statistical information extracted from the patterns. The patterns to be classified are usually groups of measurements or observations, defining points in an appropriate multidimensional space [2]. There is a sensor in the complete pattern recognition system that collect the facts to be classified; a feature extraction process that computes numeric or alphanumeric information from the facts, and a classification scheme that does the actual job of classifying these facts or observations, depending on the extracted features. The pattern recognition is related with classification or description and analysis of measurements taken from physical or mental process [3]. Pattern recognition is identified in the terms of character recognition or classification in precise manner. Thus our basic purpose to investigate the available methods and techniques those are related with the process of character recognition.

Character recognition can solve many real life complex problems. It plays vital role in today's life [4]. Due to changes in fonts, styles and size of a character, the complicated irregularity

among different pictorial representations of the same character have difficulty to be correctly recognized even typed optical character symbols. This irregularity of images undoubtedly widens when one deals with handwritten characters [5]. Designs of Classification method are based on the three concepts i.e. Member-roster concept, Common property concept and Clustering concept. In Member-roster template-matching concept, a classification system contains a collection of same pattern. In Common property concept, a classification system contains the common properties of patterns. In Clustering type of concept, the targeted class patterns are shown in the form of vectors which has real number components. So the unknown patterns can be easily classified by using clustering properties and can be easily classified if the target vectors are far apart in geometrical arrangement and also classified with more complex algorithms if the target vectors are nearby or if the clustering arrangement has any overlap [6-7].

There are various methods proposed in the literature for the character classification or recognition. Initially the attempts to accomplish the task were basically confined in statistical domain like Bayesian decision theory [8] but these methods have their own pros and corns. The rule used to classify the handwritten characters is called as nearest neighbor rule [9]. When the target patterns are not nearby then this algorithm works satisfactorily. Linear classification or discrimination [7] deals with assigning a new point in a vector space to a class that is separated by a boundary. There is a basic problem with the nearest neighbor rule that requires the large set of data and so query time is very slow. The same problem of large data set occurs with the linear classification method [10]. The neural networks are a well-established computational paradigm in the field of artificial intelligence (AI) [11-12]. The Biological neural network structure [13] has been simulated and modeled in a serial fashion that provides parallelism through ANN. ANN has an important advantage of adaptive nature [14] and due to an adaptive nature property; many existing paradigms can be fused into it easily. The main attribute of neural network is the ability to learn arbitrary nonlinear mapping using one of the appropriate learning rules. After train the ANN system, it can use for the pattern classification [15], pattern association, pattern mapping, pattern grouping [15], and feature mapping pattern and optimization control etc. After accomplish the task of pattern classification & pattern mapping, the supervised multilayer feed forward neural network [16,17] is considered with nonlinear differentiable function in all processing units of output and hidden layers. In the input layer, the number of processing units are linear that corresponds to the dimensionalities of the input pattern. In the pattern classification, total number of output unit is related to number of correspondent distinct classes. for capturing the mapping explicitly in a set of input output pattern pair, we train a network and make prediction for the new or untrained set of data by modeling the unknown system and for this purpose, an importing procedure has been created [18].

The hand written curve scripts of English words recognition is one of the important areas of research for pattern recognition due to its complexity and efficiency in the results. Segmentation of cursive word is little bit complicated process [26]. The pattern classification for the handwritten cursive English vowels and also for the alphabets has been implemented with hybrid evolutionary algorithm [19, 20]. Pattern recognition task can be performed by the statistical, structured and neural network based methods. The difficulty with the hand written words recognition due to different style of writing of the user, suggest that the artificial intelligence based methods can perform better. The statistical and structured methods have some limitations, because of less computing capabilities. A conjugate descent gradient has used for neural network's training and character's recognition [21]. Performance evaluation of multilayer feed forward neural network for handwritten English vowels characters evaluate the performance between two backpropagation learning algorithms [25]. The pattern association network of Hopfield type has also used to store the English alphabets and the genetic algorithm has employed with this feedback neural network to perform the efficient recalling of the memorized pattern on the presentation of noisy input pattern of English alphabets [22, 23].

In this proposed work, we have considered the input data in the form of *26* different set of each handwritten English characters by five different people for the implementation of feed forward multilayer neural networks for the recognition of hand written noisy English words. In our proposed method the Multilayer feed forward neural networks will train input test pattern with target output pattern for the training set of the handwritten characters of English alphabets. We use a global database for storing the large volumes of data that contains 130 character images and 546 records of data. Global database is the main part of the proposed handwritten word recognition system. Different target outputs store in global database map their patterns to final output that come from MATLAB and then desired target output is match with the different-different test inputs store in global database and the matched characters will go through post processing and the collection of characters that is the word is to be recognized.

Section 2 of this paper describes the Handwritten Character Recognition. The section 3 discusses Handwritten Word Recognition System that contains three subsections. Subsection A describes Preprocessing, Subsection B describes Segmentation of noisy English word into characters, subsection C describes Feature Extraction that discusses the approach which is used for the feature extraction of the input stimuli used for the training, and subsection D describes Pattern Mapping of Input Test Pattern & Target output pattern for different Handwritten English Characters with Global Database. Section 4 shows the results analysis and discussion. Section 5 describes the conclusion and the future scope based on this proposed work.

II. HANDWRITTEN CHARACTER RECOGNITION

Handwritten character recognition is a very well-known and common now a days in all processing of languages. Handwritten character recognition system has some methods and recognition rates that depend on level of constraints defined on handwriting. The constraints can be classified as the types of handwriting, the number of scripture, the size of the vocabulary and the spatial layout. Obviously as the constraints defined on handwriting decreases, the difficulty will be more in recognition. In case of roman script (roughly classified as hand printed, discrete script and cursive script), the difficulty will be lower for handwriting produced as a sequence of separate characters than for cursive script which has much in common with continuous speech recognition. In case of different writing systems, words recognition seems very hard as in the case of Japanese Kanji which is characterized by complex shapes and a huge number of symbols.

III. HANDWRITTEN WORD RECOGNITION SYSTEM

A recognition methodology necessarily relies on the nature of the data to be recognized. Handwritten words recognition system can be shown with the help of flowchart described in figure1.

A. Preprocessing

It is necessary that before the process of segmentation with respect to recognition, all handwritten words must be scanned into gray-scale images. Each word was fitted into a rectangular box in order to facilitate extraction from the document and to enable calculation of height and width of noisy characters. Preprocessing techniques contains three categories that is the use of global transforms (correlation, Fourier descriptors etc.), local comparison (local densities, intersections with straight lines, variable masks, characteristic loci etc.) and geometrical or topological characteristics (strokes, loops, openings, diacritical marks, skeleton). Depending on these type of preprocessing stage, various kinds of decision methods have been used such as various statistical methods, structural matching (on trees, chains), neural networks, and stochastic processing (Markov chains). Today's lots of methods combine with several techniques together in order to provide a better reliability to compensate the great variability of handwriting.

B. Segmentation of noisy English word into characters

A wide variety of research has been done in handwritten text segmentation & recognition using neural network. Segmentation is the process of decomposition of a word image into sub-images so that each specific image represents to a character. For segmenting a word into characters, a heuristic algorithm based on histogram of word image has given 75% result [24].

Recognition strategies heavily depend on the nature of data to be recognized. Because of characters in a word can be connected together in roughly writing and can be missing in cursive case, the problem may arise due to ambiguity in writing style.

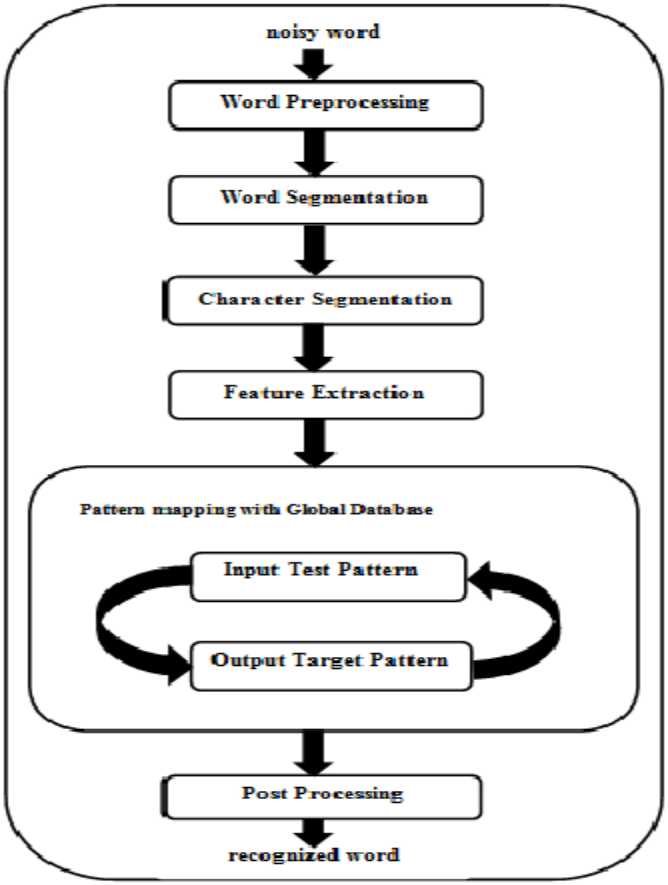

Fig. 1. Handwritten Word Recognition System

On the other side, hand written word recognition is more related to printed word recognition, the individual separate characters composing the word being usually much easier to isolate, to separate and to identify. It can be shown in figure 2.

Fig. 2. Segmentation of word "mathura"

As a consequence of this, methods working on later basis (based on character segmentation and recognition) are well suited to hand written word recognition while cursive scripts require more specific or sophisticated techniques. Innate unclearness must then be improved by the use of contextual information. Keeping in mind the scope of the recent researches in handwritten noisy curve scripts of English words recognition with hybrid evolutionary algorithms, it is proposed to undertake the study of following paradigms and problems in the pattern recognition domain. The problem of recognition for the noisy

curve script of English words is a problem of sophisticated nature and requires good accuracy for its practical implementation of the real world problem. We can see this process of segmentation with the help of an algorithm VerticalSegment [23].

C. Feature Extraction and Implementation

Feature extraction and selection is the process of extracting the most representative information from the raw data, which minimizes within class pattern variability while enhancing the class pattern variability. For this purpose, a collection of features or set of features are extracted for each class that helps to distinguish it from other classes, while remaining invariant to characteristic differences within the class. A sample of English Alphabets characters set is provided in table 1.

TABLE I. A SAMPLE OF ENGLISH ALPHABETS

A	B	C	D	E	F	G	H	I	J	K	L	M
N	O	P	Q	R	S	T	U	V	W	X	Y	Z

In this proposed work, we have considered the feature extraction from the input stimuli by using density function of MATLAB. In our approach we have considered the input data in the form of *26* different set of each handwritten English characters by five different peoples. It is quite natural that the five different people considered the different hand writing and different writing style for every character. So, in this way we have total 130 samples of the different English character sets. Each character set is containing different examples of same sample in different hand writing as shown in figure 3.

Now to prepare our training set of input output pattern pairs, we consider each scanned hand written character as a bit map image. This bitmap image of a character is now partitioned in 4 equal parts. After this row wise & column wise mean of each partition is obtained by using coded MATLAB function "*Mean_character_recognition.m*", we obtained 4 real number values for each scanned image. Hence every scanned image is now considered in the form of input pattern vector of 4 dimensions. Thus we consider each input pattern vector in the form of 4X1 row matrix form. The example of five such characters & its representation in input pattern vector form can be shown in table 2.

All collected handwritten characters images were partitioned into four equal parts, and then density values of the pixels for each part were calculated. Four values were obtained from an image of a character of handwritten English alphabets, which were then used as the input for the feed forward neural network. For each of the sample of English characters of alphabets, this procedure was used to present the input pattern to the feed forward neural network. So that in this way we can determine the input pattern vector for every scanned image.

Fig. 3. Scanned Image of 26 Different Samples of Handwritten Characters of English Alphabet

TABLE II. INPUT PATTERN VECTOR OF ORDER (4X1) FOR DENSITY VALUES MATRIX OF FIRST FIVE HANDWRITTEN CHARACTERS OF ENGLISH ALPHABETS FROM MATLAB FUNCTION

A	[2.468846; 2.252970; 2.350481; 2.361389]
B	[2.550000; 2.363670; 2.550000; 2.548854]
C	[2.165954; 2.304273; 2.318714; 2.382062]
D	[2.421460; 2.359452; 2.363312; 2.331768]
E	[2.480506; 2.386311; 2.550000; 2.550000]

Thus we have the training set which consist with 130 input pattern vector of size 4X1. It means if we consider the entire training set as matrix of training pattern than it will be the order of 4X130. To distinguish each character set from other character set for classification during the training, the target output is needed. Therefore In case of classifying these English characters, there must be 26 different classes. In this proposed method we are considering the target output pattern for each character in 26 bit binary form as shown in figure 4.

In this figure of table, presence of 1 indicates the corresponding character. Like 1 in first column means the character is "A" second place 1 means character "B" and so on.

Thus, we have constructed the training set of input output pa-

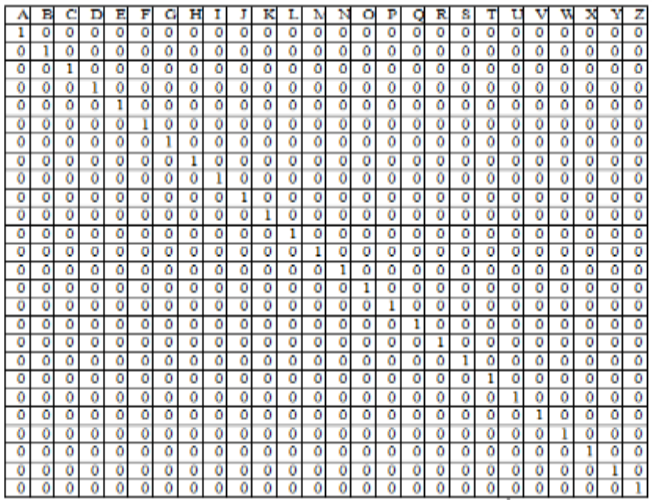

Fig. 4. Target Output Pattern for Handwritten English Characters of alphabets

-tterns pair to analyze the performance of multilayer feed forward neural networks with Feed forward backpropagation algorithms.

D. Pattern Mapping of Input Test Pattern & Target output pattern for different Handwritten English Characters with Global Database

Global database is one which is used to map the Density values of handwritten English characters of input test pattern to density values of handwritten English character of target output pattern stored in global database. It is very difficult to analyze the performance and to generalize the proposed methods because the global database that we are using here is little bit small. The small number of images of characters and their values are to be considering in database. Complexity increases on comparing the truth and false of an approach in absence of global database. So modeled global database is needed for testing and therefore we treat a representative modeled small database as a global database containing 130 character images and 546 records.

Global database is the main part of the proposed handwritten word recognition system that is used for storing the character images of different test inputs and different target outputs for pattern mapping. Different target outputs store in global database map their patterns to final output that come from MATLAB and then desired target output is match with the different-different test inputs store in global database and the matched characters will go through post processing and the collection of characters that is the word is to be recognized. It can be shown in figure 5.

IV. RESULT ANALYSIS AND DISCUSSION

From the results, the following observations are made:

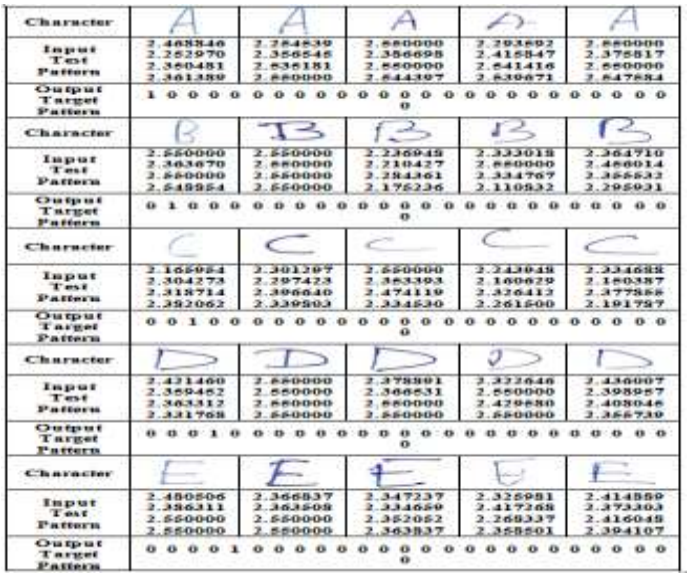

Fig. 5. Pattern Mapping of Input Test Pattern & Target output pattern for first five different Handwritten English Characters with Global Database

1. It is expected that the proposed architecture of the neural network will improve the Performance in terms of accuracy and rate of convergence for the recognition of noisy curve scripts of English words.

2. It is proposed to undertake the problem of recognition for noisy curve scripts of English words with feed forward neural network techniques. In this attempt different set of handwritten English alphabets will consider as the training set. The feed forward neural network will train these training sets of pattern with backpropagation learning algorithm.

3. It is also proposed to consider the techniques of image processing for the segmentation of the handwritten cursive words to extract the features for the construction of training patterns. All hand written words are scanned into gray scale images. There is a necessity slant detection and correction technique which is to be used for many cursive words that are slanted at various angles in the image. A rectangular box is to be used to fit each word in order to be extracted from the document and this way they can contribute into the calculation of height and width for the feature extraction. During this preprocessing the MatLab will use to determine the features from the input information of scanned image of cursive words. This prepossessing will perform in various ways like tangent method, edge detection method, average height method, and density measurement method.

4. In structure of the neural networks the scanned image of the cursive word is segmented in to individual characters and the bitmap of each character is prepared. The number of units in the input layer will be equal to the dimension of input pattern or number of bits for the characters. The input pattern of larger dimension will map in the grid of output layer of neural network with reduced dimension. This self-organizing map for each input

pattern will represent the distinct and common features for all the patterns of training set.

5. It is proposed to perform an experiment which demonstrates that for the given set of problems that is Automatic handwritten recognition for noisy English word, the performance of feed forward neural network is better than the other algorithm discussed in terms of the accuracy and rate of convergence.

V. Conclusion and Future Scope

In future, recognition of hand written noisy (unconstrained) English words will be implemented with hybrid evolutionary neural networks.

1- The performance of the proposed neural network will verify with the test pattern of hand written curve script of English words. It is expected that the neural network should able to recognize the alphabets correctly from the given input sample of handwritten English word.

2- The performance of neural networks will verify from the test pattern set. In this process also the features of the test sample will obtain from the self-organizing map and the formed test input pattern will present to the trained neural network for its recognition.

It is to be expected in our preliminary research of noisy word recognition that neural network will be a most important tool for the implementation of the word recognition system and it will enhance the performance in terms of accuracy, rate of convergence and error tolerance. The huge number of applications in several domains increases as constraint and error rate decreases. Hence, with the help of MATLAB tool, we can achieve new challenges with greater flexibility, efficiency and productivity of the developers by reducing the complexity of coding that will bring the ongoing studies closer to noisy handwritten word recognition processing which is the ultimate aim.

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