Artificial Neural Network Application In Letters Recognition For Farsi/Arabic Manuscripts

Farhad Soleimanian Gharehchopogh, Ezzat Ahmadzadeh

Abstract:- Letter recognition for manuscript is one of the categories that has been deliberated in recent years and has many applications. Considering variety of hand writings correct recognition of manuscript letter has many difficulties. In literature various algorithms has been used to letter recognition for manuscript in different languages. Regarding to artificial neural networks (ANNs) abilities in machine learning, parallel processing, flexibility and pattern recognition it would be a convenient method to be used in this field. In this paper, we proposed an ANN based algorithm to letter recognition for Farsi/Arabic manuscript. Finally, we illustrate that proposed method is one of the best method to be used in letter recognition for Farsi/Arabic manuscript.

Keywords:- Artificial Neural Networks, Back Propagation Algorithm, Letter Recognition, Multi-Layer Perceptron, Farsi/Arabic, Manuscripts

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1 Introduction

LETTER recognition is one of the categories which has no special rule or method and such a system can be designed in many different ways .Various methods has been proposed for letter recognition and everyone has its own advantages and dis advantages. Recognition process is a process should have much iteration to gain desired results. During letter recognition phase system's reactions and behavior of information which is being processed specially images including noise should be carefully investigated [1]. Majority of hand written images regarding variety of hand writings and kind of pen which has been used to write the letters has no convenient quality and includes more noise rather than typographical letters [2]. So, we encounter additional problem to recognize the hand written letters .Thus, we have to remove the noises and unused information firstly. Every letter has its own characteristics which during the processing phase this characteristics should be considered carefully [3].Some kind of hand written characters are ambiguous and this ambiguity has great role in recognition and according to this issue system training to recognize this letters will be difficult [4].We can classify the letters and put the letters with common characteristics in same class. Artificial Neural Network (ANN) ability in pattern recognition is more than other methods. This ability can be count as an advantage of using ANN in letter recognition [5]. Generally, ANN is to be used in simulating and solving problem which has no special method to solve [8] and letter recognition is one of the problems which has no special method or algorithm and can be implemented in many ways.

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ANN has learning ability and can be trained before using and after training and testing the network can be used in practice. Learning phase in ANN is with making changes in input weights. There are three methods of learning. Supervisor learning, unsupervised learning and reinforcement learning [6, 13]. We will use supervisor learning method in the proposed method which is detailed as follows. The aim of this paper is to propose an ANN based method to recognize hand written letters which can be used in all languages but proposed method is investigated for letter recognition for Farsi/Arabic manuscript. In fact, the proposed method can be used for all other languages. In this paper we have chosen 10 numbers of Farsi/Arabic manuscript in random. There are 50 samples of each letter which all of them are stored in fixed size .Colored images can cause problem during the process. Firstly, we convert colored images to bitmap images then we illustrate how to design the layers of proposed ANN. The paper deals with the proposed ANN to manuscripts recognition in Farsi/Arabic language. Second section of paper is a review of literature and methods which has been used to recognize hand written letters. Third section illustrates how to design proposed ANN and determining the layers of designed ANN and showing results of the proposed system. Fourth section of this paper is conclusions of the proposed method and future works.

2 MANUSCRIPT RECOGNITION

Hand written letter recognition is implemented using various methods. Jaberian [14] has implemented the hand written letters recognition using peak pen movements in his thesis which is one of the other methods but in case of carelessly writing letters the method is not able to recognize. Kochari et al. [14] have proposed new method for typographical letter recognition using fuzzy method. The method is not convenient for hand written letters but good for typographical letters [13]. Chiang [15] presented a new method for English hand written letters recognition which uses crucial feature of every letter and confusion regions to identify the patterns. This the method splits the pattern into parts in order to reveal the similarities and shows crucial combination plays an important role to distinguish the patterns and also a comparison has been made between present method and old ones and have extended recognition threshold rate less than 100% [15]. Also reference [16] proposed a hybrid neural network recognize

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English hand written letters. The letter images are the input of neural network and segmentation as a preprocessing method is done to classify the images. The method uses (SOFM) and (MLFM) [16]. Reference [17] proposed another method for Arabic letter recognition which uses machine learning and a proposed algorithm to recognize them. The proposed method manually creates a dictionary to cover letters and uses forty samples which has been written by different writers and obtains 86.65% recognition accuracy [17]. Kang and Brown [10] presented a novel combination of the adaptive function neural network (ADFUNN) and on-line snap–drift learning to recognition of handwritten digits. The unsupervised single layer snap–drift is used to extract distinct features from the complex cursive letter warehouses and the supervised single layer ADFUNN is able to solve linearly inseparable problems. The results indicate that the combination of these two methods is more powerful and simpler than Multi-Layer Perceptron (MLP) for this special application. Mahmoudi at al. [18] proposed a novel method for handwritten letter recognition by employing a hybrid Back Propagation (BP) algorithm in ANN with an enhanced evolutionary algorithm which BP algorithm is used for the local search and evolutionary algorithm is used for the global search of the search space for 26 English single alphabetical letters. The results show that the designed ANN provides very satisfying conclusions with relatively scarce input data and a promising performance improvement in convergence of the hybrid evolutionary and BP algorithms. This approach is suitable to recognizing the Farsi/Arabic manuscripts in various styles, but in block separate letters [18]. In addition, reference [19] compares the performance of BP algorithm with the hybrid evolutionary algorithm (EA) in feed-forward neural networks (FFNN) for English letters recognition. Also, the evolutionary algorithms evolve the population of weights of the neural network during the training phase. The results show that the performance of the designed ANN is much accurate and convergent for the learning with the hybrid evolutionary algorithm.

3 PROPOSED METHOD

Regarding to images of hand written letters are stored in fixed size on computer, ANN like any other methods has its own advantages and disadvantages in processing in various domains such as software cost estimation in [8], medical image processing in [10] and many more. In ANN architecture, there are many hidden relationships and hidden information between stored data on computer, first we use ANN to extract hidden information and relationships and learning patterns then use it in practice [9, 11, and 12]. Considering ANN's ability of parallel processing and machine learning ability is convenient method to be used to letter recognition. In this paper we choose 10 numbers of Farsi/Arabic manuscripts that all of them were stored in different size but to enter these images to neural network we have to resize all of them to be in a standard size so that useful information should not be damaged. We resized these images to 30 * 25. Now, we use some characteristics of each image to recognize it. Chosen letters are shown in the figure (1).
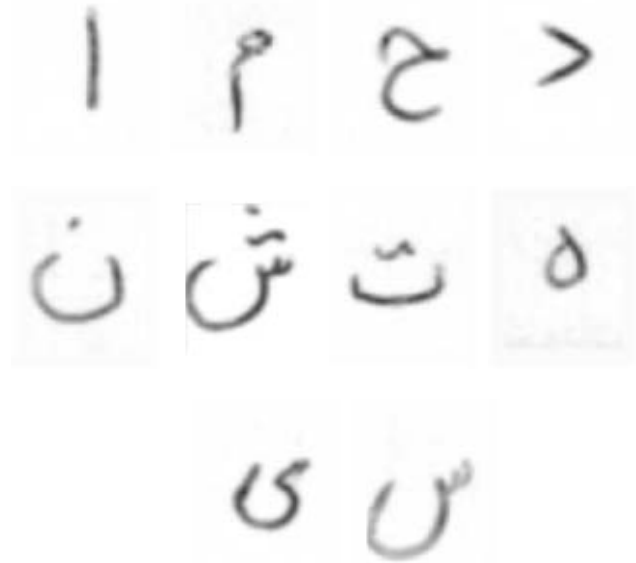

Figure (1). Sample Random Letters for Letter Recognition

Manuscripts are not linear separable problem. In proposed method we use multi-layer perceptron, back propagation learning system which is able to learn none linear problem. In this method we try to use minimum hidden layers. There are different numbers of neurons in each layer. Considering that images are stored in 30 * 25 matrix and bitmap, in proposed method we enter each row of matrix to a neuron of input layer. The matrix of each letter has 30 rows so proposed method neural network has 30 neurons in input layer. As whole this method can be used to determining of input layer in all other languages. So always we consider the neurons of input layer equal to image matrix rows. With this method neural network will be able to process different image sizes and will not be depend on image size. The kind of language has no impression on this method. We have chosen 10 letters as random and to show 10 letters we need 4 bits so we have 4 neurons in output layer. If you want to use the method to recognize more letters consider the (1).

Number of neurons in output layer= log n   (1)

Where n is the number of letters. Neurons in output layer show 0 or 1? Every arrangement of 0, 1 shows a letter as (2).

$$
\begin{aligned}
ح &= 0\,0\,0\,0 \qquad\qquad\qquad (2)\\
ش &= 0\,1\,0\,0\\
ت &= 1\,0\,0\,0\\
س &= 0\,0\,1\,0\\
ه &= 0\,1\,0\,1\\
د &= 1\,0\,0\,1\\
ى &= 0\,0\,1\,0\\
ا &= 0\,1\,1\,0\\
ن &= 0\,0\,1\,1\\
م &= 0\,1\,1\,1
\end{aligned}
$$

The number of neurons in hidden layer is calculated according to (2).

Number of neurons in hidden layer = (number of neurons in input layer + number of neurons in output layer) /3   (3)

From (4) and testing different number of neurons in hidden layer, we gained to H1-H11 numbers of neurons for hidden layer. So, proposed method has 30 neurons in input layer and 11neurons are in hidden layer and 4 neurons in output layer using back propagation learning algorithm in learning and testing phases with 1% learning rate as figure   (2)

Figure (2) ANN Architecture for Letter Recognition in Farsi/Arabic Language
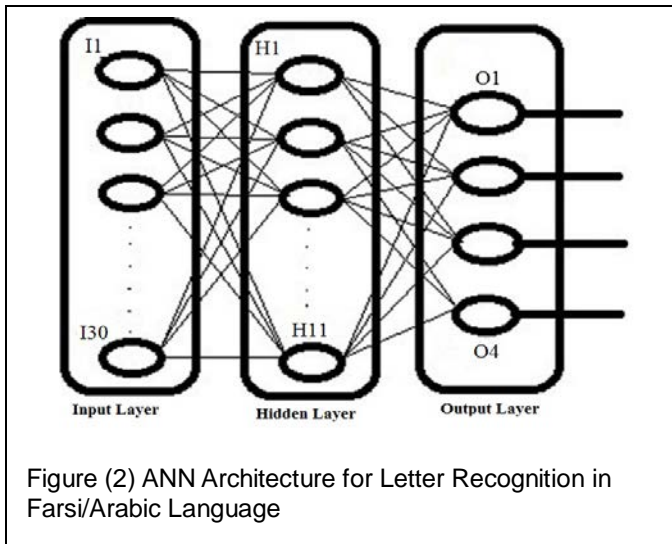
There are some ways that computer can recognize that present image is related to which class. One of them is to calculate the average data amount in each row of image matrix. In proposed method we use this way of calculating. So we calculate sum of data amount in all columns of each row and divide it to number of columns for each row. In this example number of columns or each row is 25 columns. Therefore the result image will be a 30 * 1 matrix. Now we calculate this average amount for all images. Therefore, we have 40 samples of each letter to train the network and letters are 10 numbers, the result matrix will be a 400 * 30 matrix. Now, we have to determine the target matrix. To show 10 states, we need 4 bits as shown in (2). So, the target matrix will be a 4 *1 matrix. To coordinate train matrix and target matrix consider each row of train matrix as a target. So, that target matrix will be a 400 * 4 matrix. Repeat all of above steps for test matrix too. In proposed method we use sigmoid activation function which the formula is as Sigmoid Unit Function (4).

$$f(x) = \frac{1}{1+e^{-\sigma x}}$$ (4)

Back propagation formula for updating weights is as (5)

$$\Delta w_{ji} = \lambda \delta_j o_i$$ (5)

(5) Computing changes in amount of previous weights. This λ is learning rate and δ_j for output layer is as (6).

$$\delta_j = o_j(1-o_j)(t_j - o_j)$$ (6)

(6) Computing New Weights for Output Layer δ_j for hidden layer is as (7).

$$\delta_j = o_j(1-o_j)\sum_k \delta_k w_{kj}$$ (7)

(7) Computing new weights for hidden layer.

Weight matrix is filled with random data amount. Because entering all cells of matrix will be time consuming and system may get locked at local optimums. So we use random data amount for weight matrix. If the system got locked at local optimum for first time, with random weights the next time would not be locked at local optimums. After finishing above steps the algorithm repeats following steps.

1. Fill the weight matrix with random data

2. Set the learning rate 1%

3. for all letters repeat following steps

    1. Weight matrix of hidden layer * inputs

    2. Step 1 output to $f(x) = \frac{1}{1+e^{-\sigma x}}$

    3. Step 2 output * weight matrix of output layer

    4. Step 3 output to $f(x) = \frac{1}{1+e^{-\sigma x}}$

    5. Current output – desired output

    6. Sum of error rate from step 5

    7. Weight matrix of hidden layer changes
    $$\delta_j = o_j(1-o_j)\sum_k \delta_k w_{kj}$$

    8. Weight matrix of output layer changes
    $$\delta_j = o_j(1-o_j)(t_j - o_j)$$

4. End

5. Update weight matrix of hidden layer
$$\Delta w_{ji} = \lambda \delta_j o_i$$

6. Update weight matrix of output layer
$$\Delta w_{ji} = \lambda \delta_j o_i$$

7. Test the network with step 5 and 6 weight matrixes

8. Current output – desired output

9. Sum of error rate from step 6

10. If error rate < 1% stop testing

11. Plot output

TABLE1. FLOWCHART OF BP ALGORITHM

We design a method to recognize hand written letters by applying MLP and back propagation learning algorithm. The data set was divided in two groups with following percentage ratios are shown in the table 2.

Data Type	Percentage	Number of Samples
Training Data	80%	40
Testing Data	20%	10
Total Data	100%	50

TABLE2. DATA PARTITION

By means of above definitions and algorithm the results are shown as figure (3) and figure (4). The vertical axis of the figure 3 shows the means sum of the errors in each training step which they are between 0-1.4. And also, the horizontal axis of the figure 3 shows the number of iteration in training step which they are between 0-300.
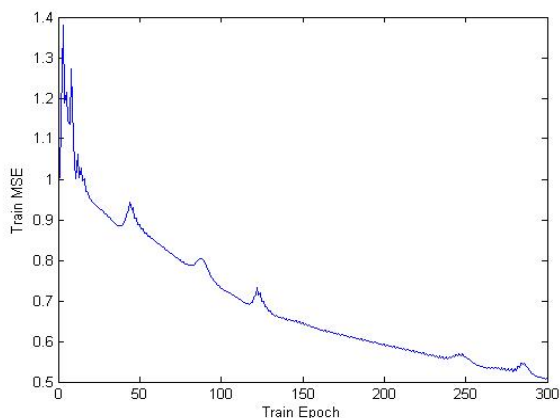

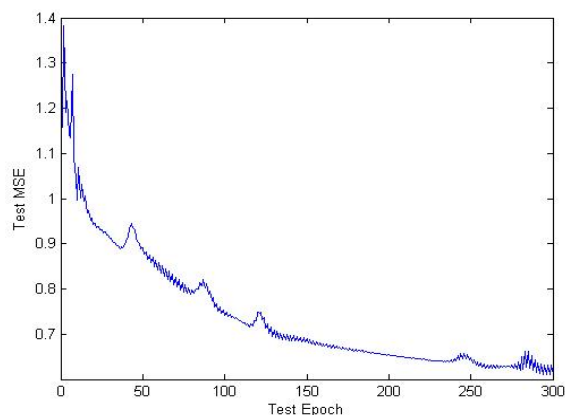**Figure (3)** Error Rate on Training Data

Figure (4) Error Rate on Testing Data

Figure (4) shows error rate in network testing step. As shown error rate is decreasing during each step of testing and finally arrives to about zero.

4 Conclusion And Future Works

Mechanization of reading hand written passages and digits has special importance in many places and proposing a method to read hand written passages and digits has a great importance. In this paper we proposed an ANN based method for letter recognition for Farsi/Arabic manuscripts which the network with minimum error rate was able to recognize discreet letters. Images of letters were resized and exchanged to standard size. This method can be used for all languages and different image sizes as well as can recognize typographical letters and digits. It shows flexibility of the proposed method and the result show that when the number of iteration is increased, the means sum of the errors are minimized. In some kind of languages discrete letters will join with each other and consist a word such Arabic and Farsi/Arabic languages and so on. This issue encounters automatic reading with additional problem. Proposing a method to read these passages is one of today's needs and would be the subject of future research.

References

[1] *A. Meisels, A. Kandel, G. Gecht , "Entropy, and the recognition of fuzzy letters", Fuzzy Sets and Systems, Volume 31, Issue 3, 20 July1989, Pages297-309.*

[2] *S.N. Srihari, "Recognition of handwritten and machine-printed text for postal address interpretation", Pattern Recognition Letters, Volume 14, Issue 4, April 1993, Pages 291-302.*

[3] *B.A. Blesser, T.T. Kuklinski, R.J. Shillman "Empirical tests for feature selection based on a psychological theory of character recognition", Pattern Recognition, Volume 8, Issue 2, April1976,Pages 77-85.*

[4] *P.S. Wang, "A new character recognition scheme with lower ambiguity and higher recognizability", Recognition Letters, Volume 3, Issue 6, December 1985,Pages431-436*

[5] *H.J. Kim, J.W. Jung, S.K. Kim, "On-line Chinese character recognition using ART-based stroke classification" Pattern Recognition Letters, Volume 17, Issue 12, 25 October 1996, Pages 1311-1322.*

[6] *S. Mozaffari, K. Faez, V. Margner, H. El-Abed, "Lexicon reduction using dots for off-line Farsi/Arabic hand written word recognition" Pattern Recognition Letters, Volume 29, Issue 6, 15 April 2008, Pages 724-734.*

[7] *A. Vinciarelli, J. Luettin, "A new normalization technique for cursive handwritten words", Pattern Recognition Letters, Vol. 22, Iss. 9, July 2001, pp. 1043-1050.*

[8] *F. S. Gharehchopogh, "Neural Network Application in Software Cost Estimation: A Case Study", 2011 International Symposium on Innovations in Intelligent Systems and Applications (INISTA 2011), pp. 69-73, IEEE, Istanbul, Turkey, 15-18 June 2011.*

[9]   *S.Sathasivam, "Application of neural networks in predictive data mining", 2nd international conference on business and economic research (2nd icber 2011),March 2011, Pages 371-376.*

[10]   *M. Kang, D. P. Brown, "A Model Learning Adaptive Function Neural Network Applied Handwritten Digit Recognition", Information Sciences, Special Issue on Industrial Applications of Neural Networks, Vol. 178, Iss. 20, 15 October 2008, pp. 3802-3812.*

[11]   *W. Gao,"New Evolutionary Neural Networks", International Conference on Neural Interface and Control, Wuhan Polytech. Univ., China, Pages 167-171, May 26-28 (2005).*

[12]   *[12] Manish Mangal and Manu Pratap Singh, "Patterns Recalling Analysis of Hopfield Neural Network with Genetic Algorithms". Accepted for publication in International Journal of Innovative Computing, Information and Control, (JAPAN), 2007.*

[13]   *A. Kochari, J. Azimi, A. Mohabadi, "Letter Recognition Using Fuzzy Logic", Second International Conference of Information Technology (Language : Farsi)*

[14]   *S. Jaberian, " Letter Recognition Using Pen Movement for Farsi Manuscript", MS.c Degree, Computer Department of Isfahan, Winter 1376(Language :Farsi).*

[15]   *J.H.Chiang, "Crucial Combinations for the Recognition of Handwritten Letters", Pattern Recognition Letters, Vol. 21, Iss. 10, September 2000, Pages: 873-898.*

[16]   *J. H Chiang, "A hybrid neural network model in handwritten word recognition" Original Research Article Neural Networks, Vol. 11, Iss. 2, 31 March 1998, Pages: 337-346.*

[17]   *A. Amin, "Recognition of hand-printed characters based on structural description and inductive logic programming" Pattern Recognition Letters, Vol. 24, Iss. 16, December 2003, Pages: 3187-3196.*

[18]   *F. Mahmoudi, M. Mirzashaeri, E. Shahamatnia, S. Faridnia, "A Novel Handwritten Letter Recognizer Using Enhanced Evolutionary Neural Network", ICST Institute for Computer Sciences, Social Informatics and Telecommunications Engineering 2009, LNIcst 8, Pages: 1-9, 2009.*

[19]   *Mangal, M., Singh, M.P, "Handwritten English Vowels Recognition Using Hybrid Evolutionary Feed-Forward Neural Network", Malaysian Journal of Computer Science, Vol. 19, Iss. 2, Pages: 169–187, 2006.*

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