Arabic Character Recognition Using Neural Networks

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Abstract: - This paper proposes a technique for recognizing Arabic characters. This technique involves of three parts: body classifier, complementary classifier, and aggregate classifier. The body classifier is designed to recognize the main body of the unknown character. It uses a Hopfield network to enhance the unknown character and to get rid of noise and associated complementary. Furthermore, it uses a backpropagation network to recognize the main body of the enhanced unknown character. The complementary classifier is responsible of recognizing the number of dots or zigzag that are associated with the body of character and their position. The aggregate classifier combines the results of the previous two classifiers and classifies the whole unknown character. The proposed technique has been implemented shown a reasonable recognition rate.

Key-Words: - Neural Networks, Backpropagation Network, Hopfield Network, OCR, Character Recognition, Arabic Character Recognition, Pattern Recognition.

1 Introduction

One of the important aspects of automation is Optical Character Recognition (OCR). OCR is the process of translating the graphical document into a textual one. Despite of the large number of researches have been done in this field, there is no obvious mathematical function that could perform this translation [1]. Considerable attention has been paid to Latin and Chinese character recognition, while Arabic character recognition still limited in spite of the challenge due to the difficulties of these characters [2-5].

From the character recognition point of view, the Arabic character recognition is a large problem [5]. This problem arises from the characteristics of Arabic characters and the way these characters are connected and written [6]. Many researches have been done on the Arabic characters [7-12], but a few of them have used neural networks [3, 13].

This paper uses two neural networks to recognize the Arabic characters: Hopfield and backpropagation.

The Hopfield network is a recurrence autoassociative network that works as a memory that can store patterns. It is a single layer network with fully connected neurons. This network returns the stored pattern when the input of the network the same as the stored one even it is a noisy version of the stored pattern [14, 15].

In this paper, the Hopfield network is used for eliminating noise and enhancing the body of the unknown character.

The backpropagation network (BPN) is a multilayer neural network trained by backpropagation of errors algorithm. It is simply a gradient descent method to minimize the total squared error of the output computed by the network. The training of a network by backpropagation involves three phases. These phases are feed forward of the input training pattern, backpropagation of the error of this pattern, and updating the weights. After training, the network is applied by using the feed forward phase of the training algorithm [14,15,16].

A multilayer neural network trained by backpropagation is used in this paper to recognize the main body of the unknown character.

This paper is organized in four parts. First, the Arabic characters are analyzed and the main problems of these characters are presented. Second, the classification technique and the classifier organization are explained. Third, result and performance of the proposed technique are compared with a backpropagation network that is trained to recognize the Arabic characters (this backpropagation network will be called traditional backpropagation network). Finally, a general conclusion terminates the paper.

2 Features of Arabic Characters

Arabic writing and Arabic characters have many features that make the Arabic character recognition system differs than the recognition systems for other languages such as Latin and Chinese. Arabic words

are written from right to left in a cursive script in both handwritten and typewritten [2-5]. Also, Arabic characters have many characteristics that complicate the recognition of such characters. Some of these characteristics are listed below:

1. Arabic alphabet consists of 29 characters. The shape of most of these characters is a function of their positions within the word, where each character can have up to four different forms that increase the number of patterns from 29 to about 60 patterns [2]. Table 1 shows the Arabic character patterns (each table cell contains one character with different shapes).
2. Most of Arabic characters (17 of 29) have a character complementary that is associated with the body of the character. This complementary may be dot, two dots, three dots, or zigzag (in Arabic it is called hamza). It can be above the character (ف), below (ب), or inside the character (ج) [5].
3. There are many groups of characters that have the same body, but they are distinguished by the number of dots (ـتـثـ), the position of dots (ج،خ), or whether it is dot or zigzag (ـئـ) [5].

مـ م	عـ عـ ـع ع	سـ س	حـ ح	ء ئ ئ
نـ ن	غـ غـ ـغ غ	شـ ش	خـ خ	ا
هـ هـ ـه ه	فـ ف	صـ ص	د	بـ ب
و	قـ ق	ضـ ض	ذ	تـ ت ـة ة
يـ ي ي	كـ ك	ط	ر	ثـ ث
	لـ ل	ظ	ز	جـ ج

Table 1. Arabic Character Patterns

3 The proposed Technique

There are two major problems in Arabic characters that are regarded in this paper. These problems are:

1. *The similarity among each group of different characters*. It is more important problem in Arabic character recognition system. This problem makes the recognition system unable to absolutely decide what character is under recognition. This problem is due to the character's complementary structures. The dot has no specific shape and can be regarded as a spot of few pixels. The size of this spot determines the number of dots. Whereas the zigzag has a specific shape. Therefore, any considerable noise may influence the recognition system since the noise may be considered as complementary of the character.
   Thus, the noise removing process requires high attention to avoid removing the complementary.

2. *The large number of patterns of Arabic characters*. This problem is due to the multiform of each character depending on the character position within word. This problem causes large number of classes that complicate the recognition system.

In order to solve the above problems, this paper proposes a recognition technique that is divided into three parts: body classifier, complementary classifier, and aggregate classifier. This organization reduces the large number of patterns into to 33 patterns as well as minimizing the similarity among the patterns of different characters. Table 2 shows the body of characters.

و	م	ف	ط	د	ء
ى	ن	ق	عـ	ر	ا
ى	هـ	كـ	عـ	سـ	ـد
	هـ	لـ	ـع	س	ـب
	ـه	لـ	ع	صـ	حـ
	ه	مـ	ف	ص	ح

Table 2. Main Body of Arabic Characters

3.1 Body Classifier

This part is designed to classify the main body of the unknown character regardless of the dots or zigzag. In addition, it is responsible of removing the noise and enhancing the main body of the character . This part classifies the main body through two stages. Fig.1 depicts the objective of this classifier.

3.1.1 First stage

This stage enhances the unknown character and removes the noise and character complementary that is associated with the body of the character. In this stage we use a Hopfield network. To enable this network of removing the noise and enhancing the body of the character, we store the body of Arabic characters within it. Thus, this network will consider the character complementary as a noise and the output of the network will be the stored body that is similar to the body of the unknown character.

3.1.2 Second stage

This stage receives the output of the Hopfield network (main body) as an input and outputs the class that the unknown pattern belongs to. This stage uses a backpropagation network that is trained to classify the main body of Arabic characters.

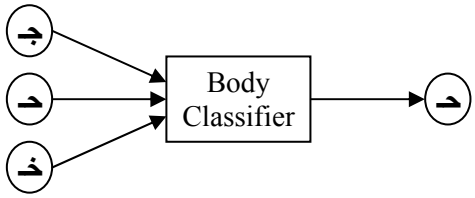

Figure (1) Body Classifier

3.2 Complementary Classifier

This part is responsible of recognizing the complementary of the unknown character. It has to determine the number of dots, position, and whether they are dots or zigzag. As it mentioned above, the zigzag has a certain shape, whereas the dots have no certain shape. Thus, the dots and their number can be recognized by their size.

In this paper, the complementary is recognized using a mask that is passed along the unknown character. Through this mask, it is easy to determine if there are dots or zigzag.

3.3 Aggregate Classifier

This part combines the results of the two previous parts and produces the class that the unknown character belongs to. Fig. 2 shows the function of this part.

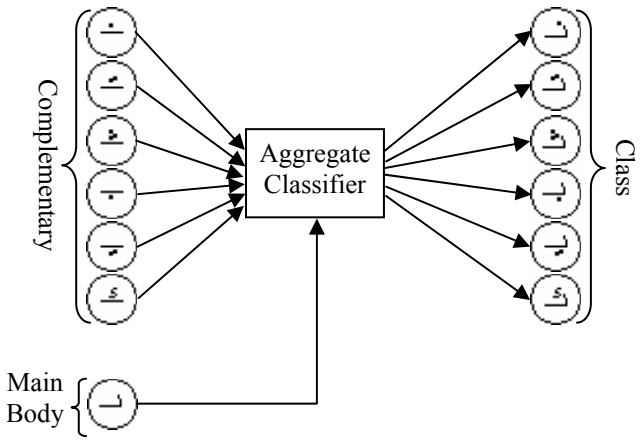

Figure (2) Aggregate Classifier

4 Results

The proposed technique has been implemented and tested along with a traditional backpropagation network. The proposed technique has proved a good behavior on two criteria:

1. Network Training

   The number of epochs that are required to train the BPN of the proposed technique is much less than the required epochs to train the traditional backpropagation network as shown in the fig.3.

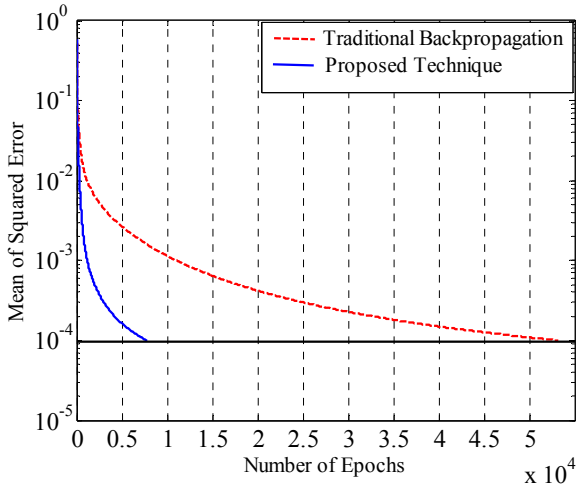

Figure (3) Training Time

2. Recognition Rate

   For both of the proposed technique and the traditional backpropagation network, the recognition rate depends on the noise rate in the unknown pattern. But, the traditional backpropagation network has shown high sensitive to the noise due to the similarity among groups of Arabic characters. Fig.4 shows the relation between the error rate and the recognition rate.

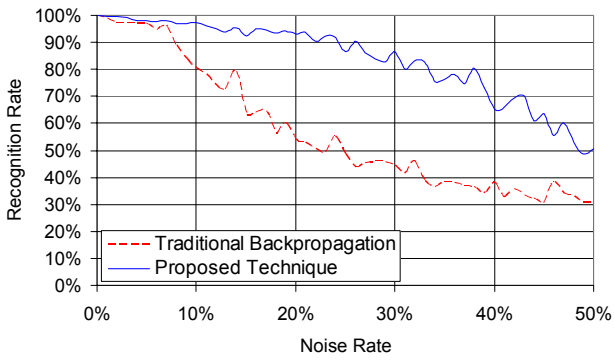

Figure (4) Recognition Rate against Noise Rate

4 Conclusion

It is obvious that the large number of epochs for training the traditional backpropagation network not only because the large number of patterns. This is also because of the similarity among groups of different characters. To enable the network of discriminating the similar classes, the network has to take a large number of epochs.

Furthermore, the traditional backpropagation network is very sensitive to the noise as shown in fig.4. This sensitivity is because of the complementary of characters that discriminate the different characters with the same body from each others. Thus, when the backpropagation network considers the noise as a complementary, misrecognition will be occurred. The organization of the proposed technique and isolating of the complementary classifier overcomes on the problem of the overlapping between noise and complementary.

References:

[1] J. A. Freeman and D. M. Skapura, "Neural Networks: Algorithms, Applications, and Programming Techniques", Addison-Wesley, 1992.

[2] Adnan Amin, "Off line Arabic Character Recognition – A Survey", ICDAR'97, pp. 596-599.

[3] A. Amin and W. Mansoor, "Recognition of Printed Arabic Text using Neural Networks", 4th International Conference on Document Analysis and Recognition, Germany, 1997, pp. 612-615.

[4] Adnan Amin, "Recognition of Printed Arabic Text Based on Global Features and Decision Tree Learning Techniques", pp. 1309-1323. vol. 33, no. 8, 2000.

[5] S. F. Saleh, "An On-Line Automatic Arabic Document Reader", MSc. Thesis, University of Basrah, Iraq, 1998.

[6] Adel M. Alimi, "An Evolutionary Neuro-Fuzzy Approach to Recognize On-Line Arabic Handwriting", ICDAR 1997, pp. 382-386.

[7] B. Al-Badr and R. Haralick, "Segmentation-free Word Recognition with Application to Arabic", 3rd International Conference on Document Analysis and Recognition, Montreal, 1995, pp. 355-359.

[8] A.M. Gillies, E.J. Erlandson, J.M. Trenkle, S.G. Schlosser, "Arabic Text Recognition System", Proceedings of the Symposium on Document Image Understanding Technology, Annapolis, Maryland, 1999.

[9] A. Cheung, M. Bennamoun, and N.W. Bergmann, "An Arabic Optical Character Recognition System Using Recognition-Based Segmentation", pp. 215-233. , vol. 34, no 2, 2001.

[10] M. Dehghan, K. Faez, M. Ahmadi, and M. Shridhar, "Handwritten Farsi (Arabic) Word Recognition: a Holistic Approach Using Discrete HMM", pp. 1057-1065. vol. 34, no 5 , 2001.

[11] Nawwaf N. Kharma, and Rabab K. Ward, "A Novel Invariant Mapping Applied to Hand-written Arabic Character Recognition", pp. 2115-2120. , vol. 34, no 11, 2001.

[12] A. Amin, "Recognition of Hand-printed Characters Based on Structural Description and Inductive Logic Programming", PRL vol. 24, No. 16, December 2003, pp. 3187-3196.

[13] S. Almaadeed, "Arabic Handwritten Characters Recognition Using Neural Network", MSc. Thesis, University of Alexandria, Egypt, 1999

[14] Laurene Fausett, "Fundamentals of Neural Networks: Architectures, Algorithms, and Applications", Prentice Hall, New Jersey, 1994.

[15] Robert Callan, "The Essence of Neural Networks", Prentice Hall, 1999.

[16] Simon Haykin, "Neural Networks: A Comprehensive Foundation", Prentice Hall, New Jersey, 2nd**.١٩٩٩edition,**