CA-5 509

MILITARY TECHNICAL COLLEGE

CAIRO - EGYPT

NEURAL NETWORK PATTERN RECOGNITION OF HANDWRITTEN ARABIC ALPHABET CHARACTERS

Fawzy Ibrahim *

ABSTRACT

The development of handwritten character recognition system has been an old puzzle to the researchers in the field. This is one field where neural networks are expected to achieve new progress. This paper presents the design and implementation of an efficient and reliable recognition software for optically scanned isolated Arabic handwritten characters. The principal goal of the study is to investigate possible applications of neural network models to implement a complete Arabic handwritten document reading system. A neural network architecture based on the backpropagation learning algorithm is used. The system output is a code corresponding to the scanned Arabic letter in a modified version of ASMO character set. This code is chosen because of its compatibility with the most Arabic word processing techniques. The effectiveness of the method has been tested on a data set of 2800 handwritten random samples. Analysis of the obtained results shows that the network accomplishes 98.21% accuracy.

1. INTRODUCTION

Machine character recognition has been a major object of pattern recognition for many years. Many handwritten character recognition researches have studied neural network. However, some of these techniques are limited to digits or numerals recognition [1-3], some others are concerned with recognition of English [4], Korean [5], or Japanese [6] characters. Perhaps because of the complexity of Arabic handwritten, as compared to other languages, Arabic character recognition remained almost untouched field until late 1980's [7-9].

Arabic language has an alphabet of 28 basic letters, and 3 other special letters. Each letter has four possible shapes depending on its position within a word, whether it is isolated, initial, medial, or terminal, as shown in the first four columns of Table. 1. The Arabic language has certain characteristics that make it different from English and other languages. These differences will show that Arabic character recognition is not a direct implementation of the recognition techniques used for English. These characteristics include: 1. Arabic text is written

* Lecturer, Department of Electrical and Computer Engineering Military Technical College, Kobry El-Koba, Cairo, Egypt.

from right to left. 2. Each of the characters can have four different shapes depending on the position in the word. 3. Many of the characters have dots at suitable distance above or below the letter body. Dots can be single, double or triple. 4. Some characters use special marks to modify the letter accent, such as Hamza (؟), and Madda (~), again positioned at a certain distance from the letter.

The objective of this work is to recognize various shapes of handwritten Arabic characters which look different almost every time they are written by the same person. Using neural network seemed appropriate to solve this problem.

2. OPTICAL CHARACTER RECOGNITION SYSTEM

The general scheme of an optical character recognition is shown in Fig. 1. The input to this system is a scanned or digitized image of a character. The output of this system is the recognized character in one of the following formats: either text or graphics mode, or a code corresponding to an Arabic letter in a modified version of ASMO character set as illustrated by the fifth and sixth columns of Table. 1. This code is used to represent the Arabic characters in the Arabic word processing packages.

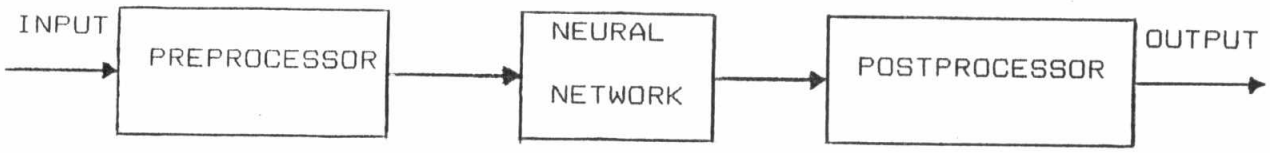


Fig. 1 General scheme for an optical character recognizer.

2.1 The Preprocessor

The preprocessing phase is done in the following sequence:

Step 1 An image file of a scanned character is read. The image information is decoded into pixels of 1's and 0's. An example of the second alphabet character "ب" is shown in Fig. 2 (a).

Step 2 The image is clipped from the four sides to keep only the useful information in a smaller size, as shown in Fig. 2 (b).

Step 3 The dots are identified to determine their numbers and positions, and then removed from the image as shown in Fig. 2 (c).

Step 4 The image is compressed to 16*16 and then to 8*8 matrix, using a compression technique.

2.2 The Neural Network Architecture

A feedforward four-layer network, as shown in Fig. 3, is used. It can be described as follows:

Input layer: an 8*8 matrix (64 nodes), fully connected to the first hidden layer.

First hidden layer: an 8*8 (64 nodes), with a patterned connection scheme to the second, using a 2*2 pattern matrix, and overlap of 1 in both the x and y directions [10].

Second hidden layer: a 7*7 matrix (49 nodes), fully connected to the third hidden layer.

Third hidden layer: a 7*7 matrix (49 nodes), fully connected to the output layer.

Output layer: an 8*1 matrix (nodes).

2.3 Training the Network

Several samples of every character's shape, ten samples of each shape written by ten different people are prepared in the way explained above (Fig. 2(d)). Then for every input a target code is assigned to form input/target pairs (see Table. 1). The system is trained using backpropagation learning rule. The training samples are presented to the network, the system parameters (such as the learning rate, the number of cycles...) are adjusted, and its output is tested. This process is repeated until all the trained characters are recognized correctly. The resulting set of weights are saved, and now the system is ready for the retrieval phase.

2.4 The Postprocessor

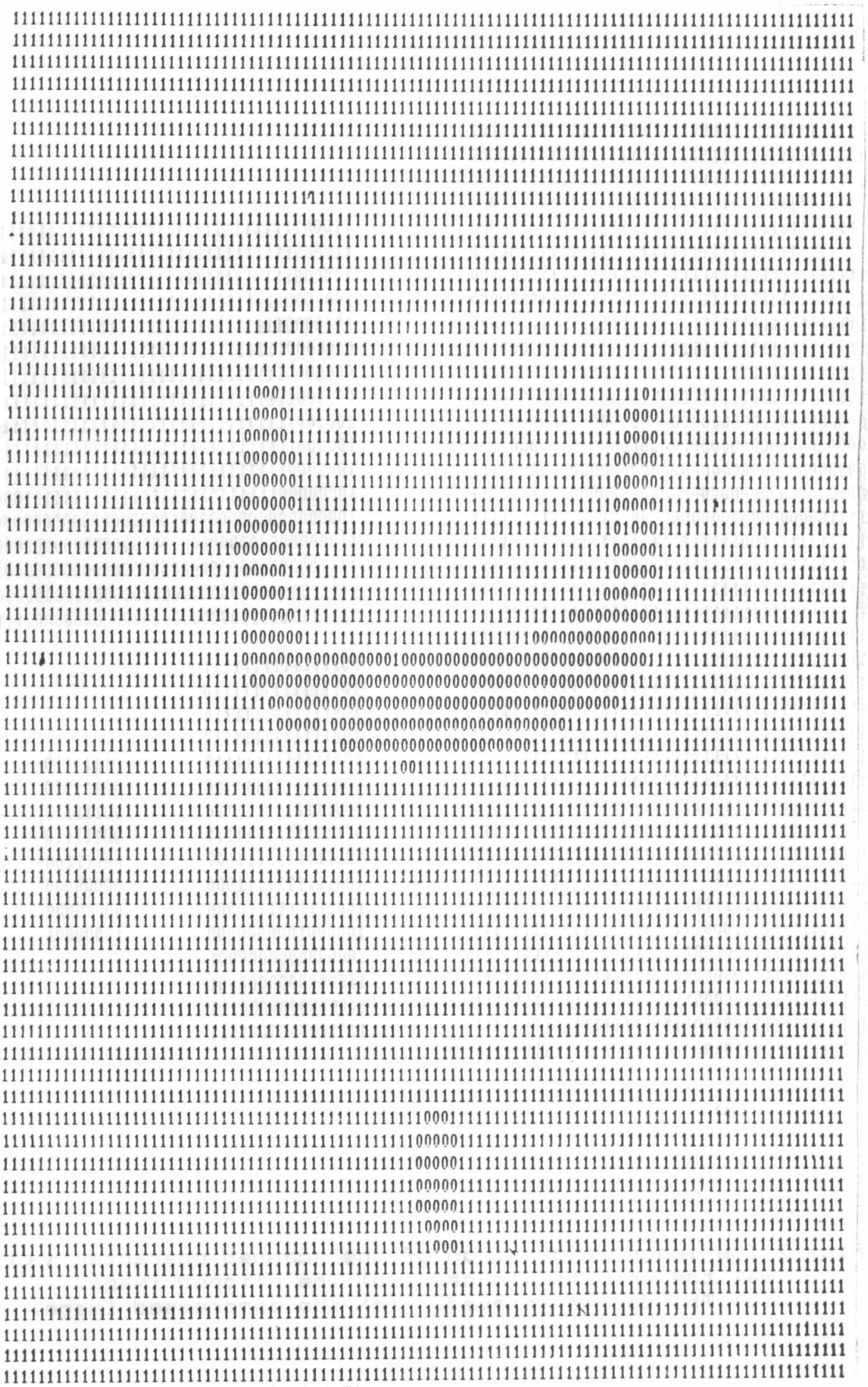
The standard ASCII table does not provide Arabic characters, so the standard ASMO codes have been used for the output. The arabic character shapes are generated and linked to the active ASCII font table.

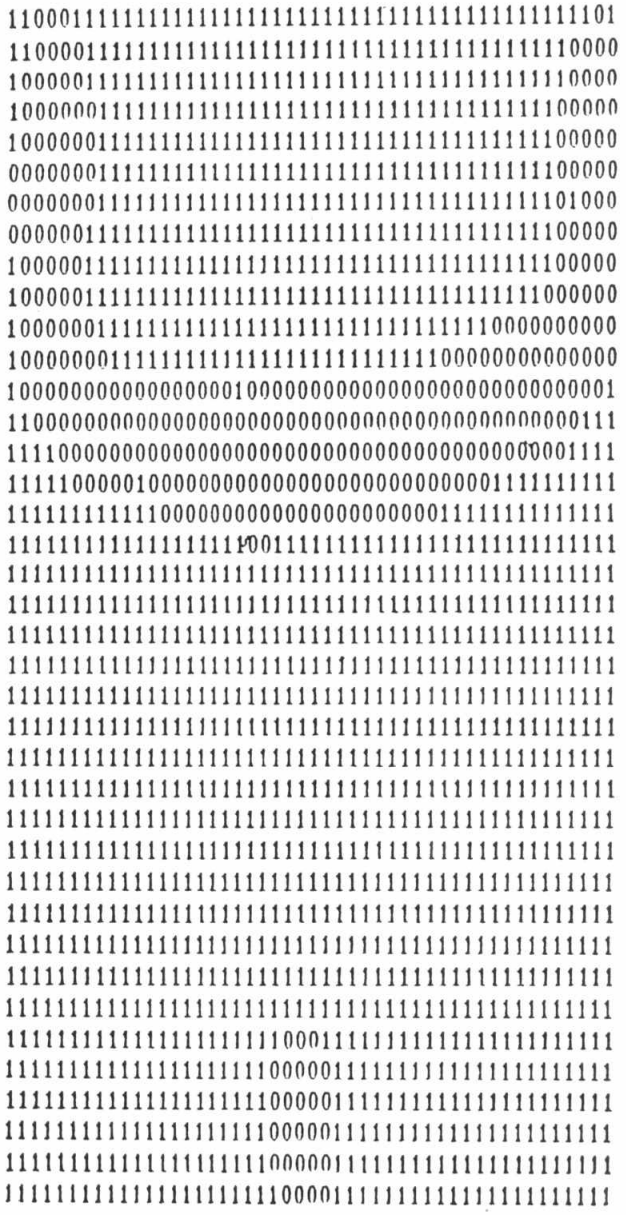
3. CONCLUSION

A model using the feedforward neural network was discussed and proved to be useful for handwritten Arabic character recognition. The system has the ability match a certain pattern to the desired output code. Furthermore, testing the network verified its capability to generalize or to recognize Arabic characters that has never seen before. The system has been tested on a huge number of characters which showed that the recognition rate is 98.21% as shown in Fig. 4, and the recognition time is equal to 0.15 second on an IBM 386-SX.

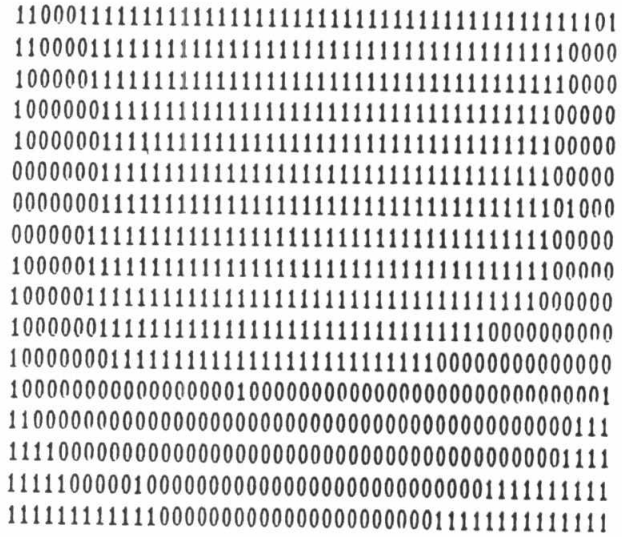
Table. 1 The basic Arabic letters in four different positions and their corresponding ASMO code.

Isolated	Initial	Medial	Terminal	Decimal Code	Binary Code
ا	ا	ـا	ـا	199	1100 0111
ب	بـ	ـبـ	ـب	200	1100 1000
ت	تـ	ـتـ	ـت ـة ـۃ	202	1100 1010
ث	ثـ	ـثـ	ـث	203	1100 1011
ج	جـ	ـجـ	ـج	204	1100 1100
ح	حـ	ـحـ	ـح	205	1100 1101
خ	خـ	ـخـ	ـخ	206	1100 1110
د	د	ـد	ـد	207	1100 1111
ذ	ذ	ـذ	ـذ	208	1101 0000
ر	ر	ـر	ـر	209	1101 0001
ز	ز	ـز	ـز	210	1101 0010
س	سـ	ـسـ	ـس	211	1101 0011
ش	شـ	ـشـ	ـش	212	1101 0100
ص	صـ	ـصـ	ـص	213	1101 0101
ض	ضـ	ـضـ	ـض	214	1101 0110
ط	طـ	ـطـ	ـط	215	1101 0111
ظ	ظـ	ـظـ	ـظ	216	1101 1000
ع	عـ	ـعـ	ـع	217	1101 1001
غ	غـ	ـغـ	ـغ	218	1101 1010
ف	فـ	ـفـ	ـف	225	1110 0001
ق	قـ	ـقـ	ـق	226	1110 0010
ك	كـ	ـكـ	ـك	227	1110 0011
ل	لـ	ـلـ	ـل	228	1110 0100
م	مـ	ـمـ	ـم	229	1110 0101
ن	نـ	ـنـ	ـن	230	1110 0110
ه	هـ	ـهـ	ـه ـہ	231	1110 0111
و	و	ـو	ـو	232	1110 1000
ى	يـ	ـيـ	ـى	233	1110 1001

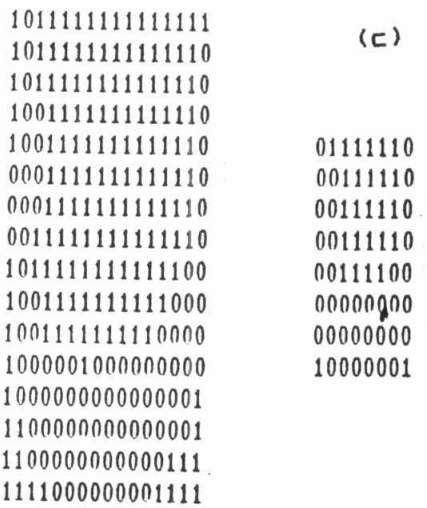




(b)



(c)



(d)

Fig. 2 The image information of the scanned character (ب).
(a) the original image. (b) The clipped image.
(c) The dot is removed. (d) the compressed image.

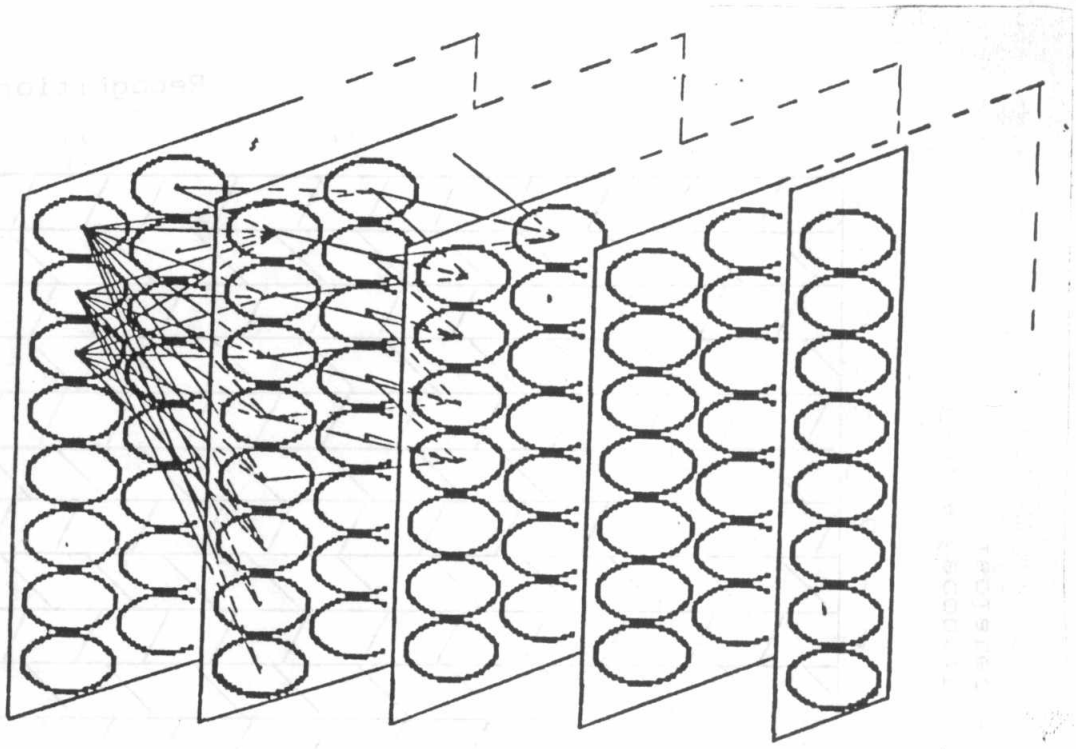


Fig. 3 The neural network Architecture

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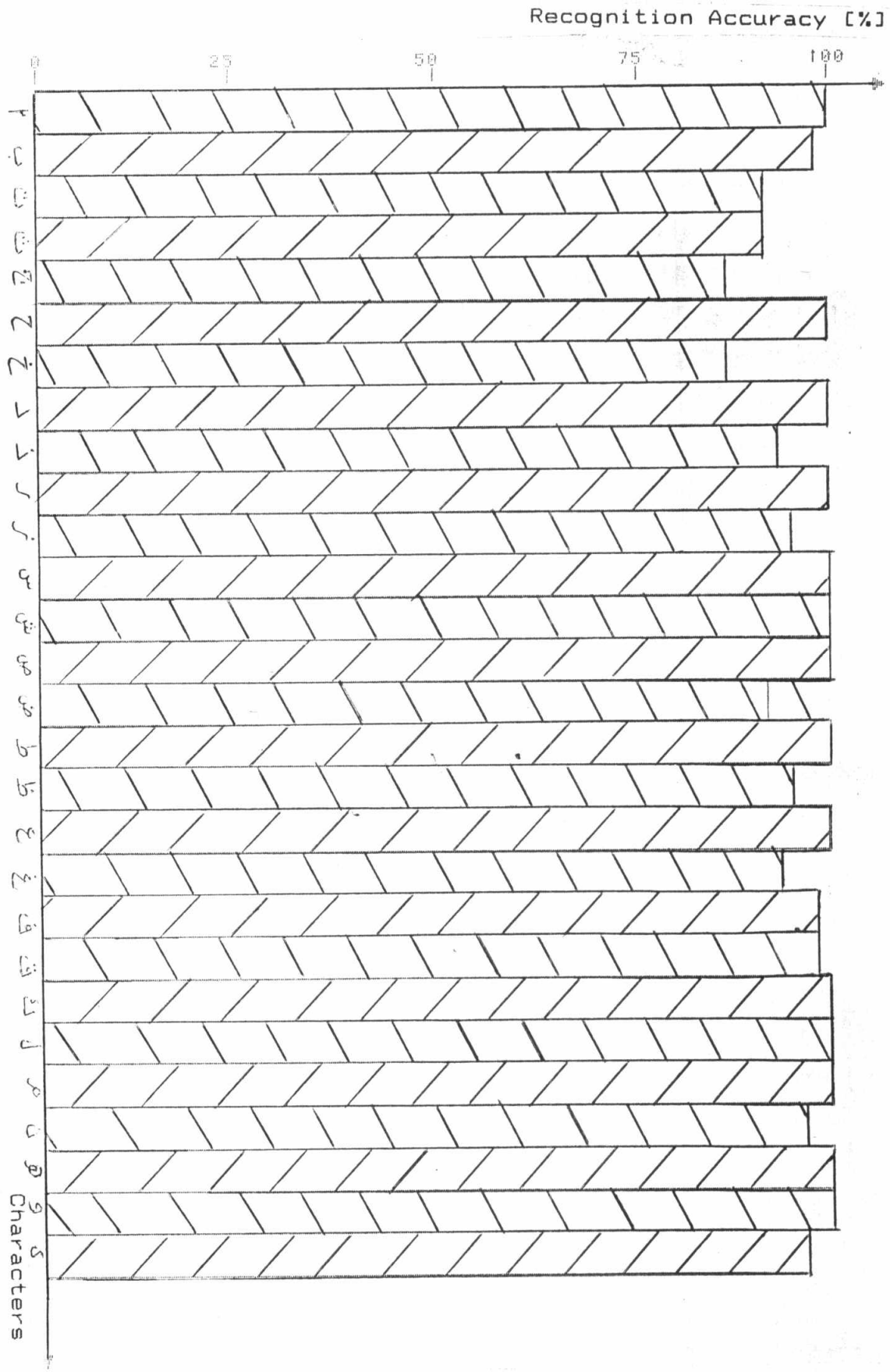

Fig. 4 Recognition accuracy for optically scanned isolated Arabic handwritten charactes