Number 4 Volume 16 December 2010 Journal of Engineering

HAND WRITTEN RECOGNITION USING NEURAL NETWORK ALGORITHM

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ABSTRACT

Hand written recognition problem can be done in two major steps, first by separating each character alone and second by detecting the separated shape to its corresponding like alphabetic letter. A backpropagation neural network found to be a good artificial intelligence algorithm in facing character recognition problem.

In this work, backpropagation neural network is used with 3-layers to detect and separate 26 English letter from (A to Z). In addition, a previous steps should be taken to detect the boundaries of each single written letter. Detecting a complete text can be done by separating each character through finding its boundaries, resizing the separated character to be suitable for pre-trained neural network, detecting the hand-written letter and finally saving the guessed letter to a text file. This work is developed using Matlab 2008 version 7.6. The obtained results show good representations of letter contaminated by noise and non-trained letters.

KEYWORDS: Character Recognition, Neural Network, Artificial Intelligence, Backpropogation, Hand written recognition

الخلاصة

مشكلة تمييز خط اليد المكتوب تتم على خطوتين رئيسيتين ، أولاً من خلال فصل كل شكل على حدة وثانياً بتمييز الشكل المفصول للحرف الأبجدي المشابه له. الخلية العصبية ذات الانتشار الخلفي وجدت كلوغارتمية ذكاء اصطناعي جيدة في مواجهة مشكلة تمييز الأشكال.

في هذا العمل، . الخلية العصبية ذات الانتشار الخلفي استخدمت بثلاث طبقات لإيجاد وفصل 26 حرف انكليزي من (A إلى Z). بالإضافة لذلك ، هنالك خطوات مسبقة يجب أن تتخذ ، وذلك لإيجاد حدود كل حرف مكتوب بخط اليد. إيجاد نص كامل ممكن أن يتم بعزل كل شكل من خلال إيجاد حدوده ، ثم تعديل حجم الشكل المعزول ليكون ملائماً للخلية العصبية المُعلمة مسبقاً، ثم بإيجاد الحرف المكتوب بخط اليد ، وأخيراً حفظ الحرف المحزور في ملف كتابة. هذا العمل أنجز باستخدام برنامج Matlab الإصدار 7.6 لعام 2008. النتائج المكتسبة أظهرت تمثيل جيد للأحرف الملوثة بالشوائب والأحرف الغير معلمة مسبقاً.

INTRODUCTION:

One of the most important applications in Artificial Neural Network field is the character recognition. It is the base for many different types of applications in various fields, many of which we use in our daily lives. Cost effective and less time consuming, businesses, post offices, banks and security systems. Whether you are processing a check, performing an eye/face scan at the airport entrance, or teaching a robot to pick up and object, you are employing the system of character recognition. One field that has developed from character recognition is optical character recognition (OCR) which is used in scanner devices to recognize a complete scanned page (graphical images form of written text) and convert them to computer typed editable text documents. Newer applications have even expanded outside the limitations of just characters. Eye, face, and fingerprint scans used in high-security areas employ a newer kind of recognition [1,2].

A system which employ connectionist network to solve pattern recognition problem are currently of greet interest. Previous work [1,3] applied a neural network to a hand writing single character. This paper discusses the recognition of hand written letter, by applying it into backpropagation neural network to solve this problem.

SYSTEM OVERVIEW

The system is organized in two stages (illustrated in Fig. 1). The first stage converts the input character into highly compressed format available for recognition. The second stage is character recognition neural network which is previously learned [4].

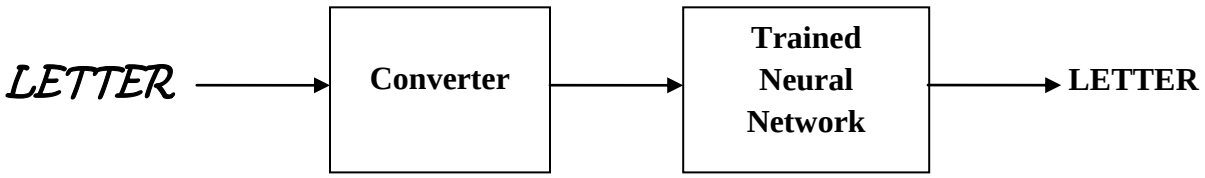

Fig. 1. Block diagram of letter recognition system

CHARACTER RECOGNITION:

Character is entered to the system as an image which produces a 9×9 matrix with a continuous stream of 1's and -1's, the 1's referred to the black part (character bits) while the -1's referred to the empty part as shown in the Fig. (2.a). The cause of selection the (1 and -1) representation in order to meet the requirements of the activation function which will be discussed later.

To provide suitable input pattern, the 9×9 two dimensional matrix converted to a vector (one dimensional array). Since each element in the vector will be represented as an input neuron to the neural network, as shown in Figs. (2.a), (2.b) and (2.c).

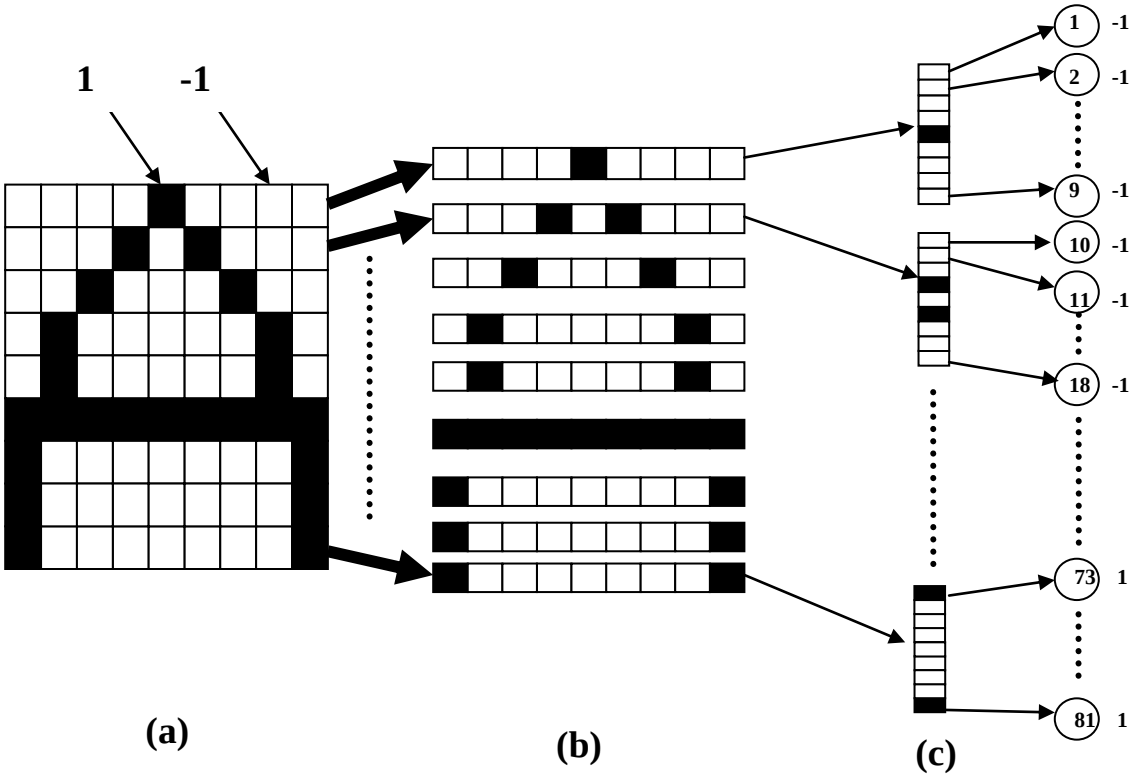

Fig. 2. Providing character to the neural network throw converting the 9×9 matrix into 81 elements vector.

NEURAL NETWORK ARCHITECTURE:

Fig. (3) describes the architecture of the neural network used in this paper. It consists of three layers (input , hidden and output layer) fully interconnected with each other by weight matrices [4,5,6].

The first layer (the input layer) consist of 81 neuron (from 9×9 = 81), each input neuron assigned to each bit of the pattern vector. The output layer with which the neural network needs to be learned is 26 neurons. The 26 output neurons refer to the number of 26 different English letters.

There are two sets of weights; input-hidden layer weights and hidden-output layer weights. These weights represent the memory of the neural network, where final training weights can be used when running the network [1].

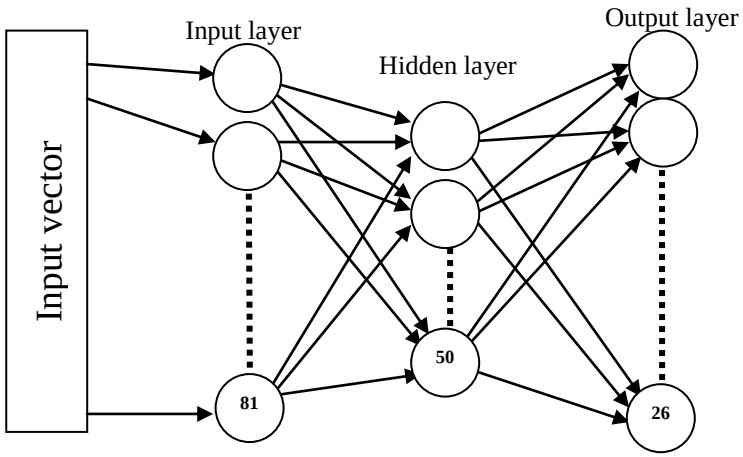

Fig. 3 . Architecture of the used neural [4,5,7].

TRAINING THE NEURAL NETWORK:

In the training phase, the neural network needs a set of input and desired output pairs for each single pattern, these set are entered by the supervisor of the network. The input vector is supplied as previously discussed while the desired output vector is set by putting a one in the output neuron location (where the character suppose to be represented) and a minus one everywhere else (the other 25 remaining output neuron) [2,6,7].

For example, to represent a pattern of A letter shape, the output vector is set as a 1 in the first output neuron (because A is the first letter in the alphabet) and -1 in output neurons from 2 through 26 neurons [2,8,9].

Many parameters should be chosen carefully before starting of the training phase. Such as the range of input values (here from -1 to 1), the range of output values (also from -1 to 1), the activation function (here it is tangent sigmoid at each hidden and output neurons illustrated in Fig. (4.b)), number of neurons at the input layer (here it is 81 and it is fixed), number of output neurons (here it is 26 and it also fixed) [5].

The training was implemented in MATLAB 2008 software package. Using a backpropagation neural network training algorithm with learning rate = 0.5, error goal = 0.001 and the number of hidden neurons were 50 neurons. Each hidden and output neurons have tangent sigmoid activation function Fig. (4) [2].

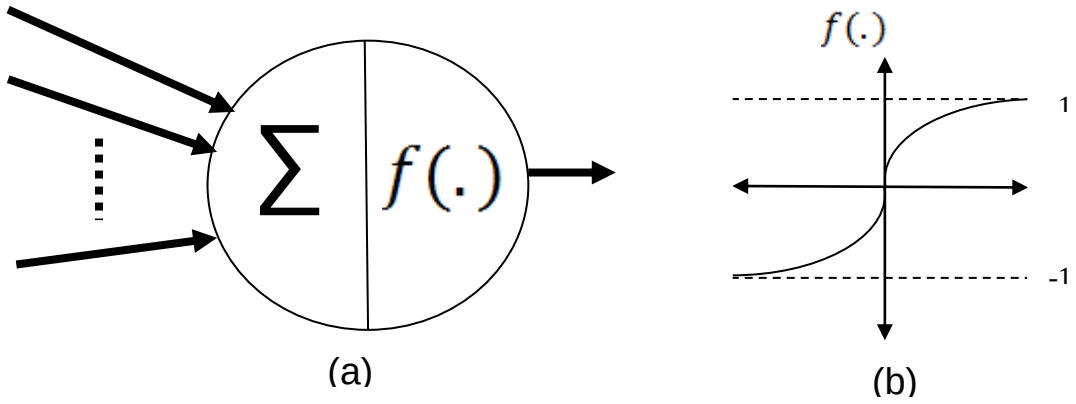

Fig. 4. Hidden or output neuron with tangent sigmoid activation function [2].

Some parameters used in the neural network have a great effects on the updating of the weights, such as (number of the hidden layers, number of the hidden neurons and the value of the learning rate), which can be tuned until a critical limit where there is no interesting of changing it . These parameters can be changed only in the starting of learning phase. Changing these parameters needs to restart the whole learning process [5,7,9].

This network was trained to recognize 26 alphabetic English letters from A to Z. Each letter with three different shapes. Therefore ; the total number of learned shaped was (26× 3=78) different patterns. one additional shape for each letter was used for testing the trained neural network.

Testing of the Neural Network:

The neural network succeeded in recognizing the letter which previously learned. It also succeeds in the same letter with some noise added into it. But changing the shape of the entered letters gives less ratio of detection than its original learned letters sets.

For example the neural network succeeded to recognize letter A Fig. (5.a) which was trained previously, but when testing the neural network with letter A in different shape shown in Fig. (5.b) the network gave a guess that the character is mostly A.

(a) (b)

Fig. 5. Two representations of letter A.

DETECTING CHARACTER BOUNDARIES:

The hand written system accepts a complete image file with written text in different rows and with shapes of letters in different sizes.

A process of detecting the boundaries of each letter shape is done by searching and detecting for each row of text alone from up of the image file to down. And for each row, from left to right Fig. (6.a).

For each detected letter shape boundaries, the size may not meet the fixed 9×9 size of the trained neural network. Therefore; resizing process (minimizing or maximizing)is done to each shape in order to be prepared for the network Figs. (6.b) and (6.c).

The input shape is ready to be enter to the neural network. The neural network then makes its decision on the current single pattern and gives the guessed letter as an output layer vector describes the letter Fig. (6.d). The recognition system translate the output vector to its corresponding letter and saves the letter in an output text file Fig. (6.e) . And the whole process is repeated again till the completion on the entire image file as shown in the flow chart in Fig.(7).

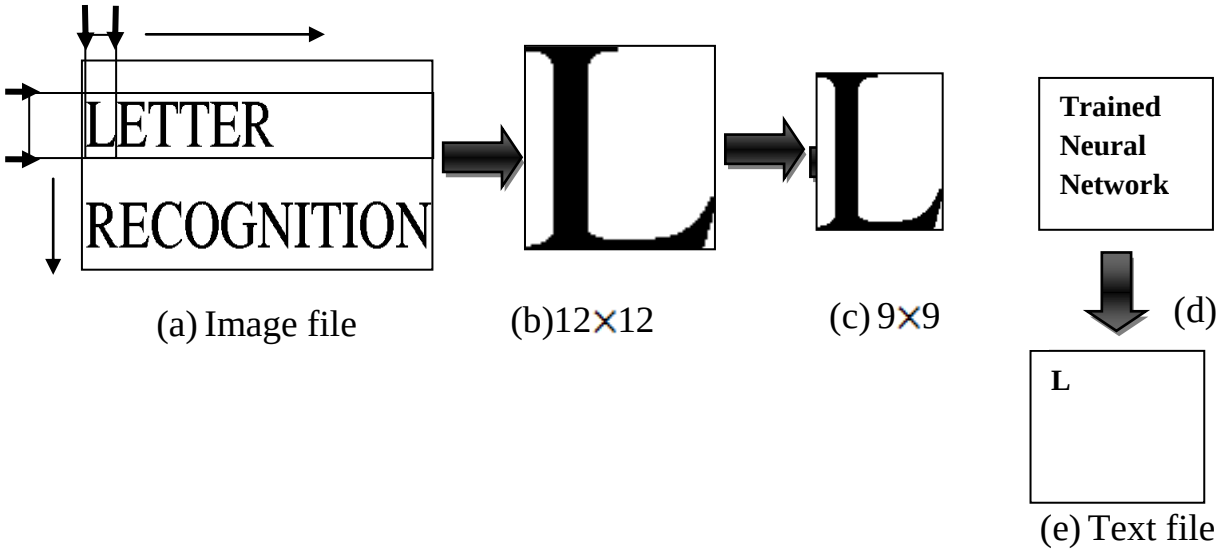

Fig. 6. The process of letter recognition step by step.

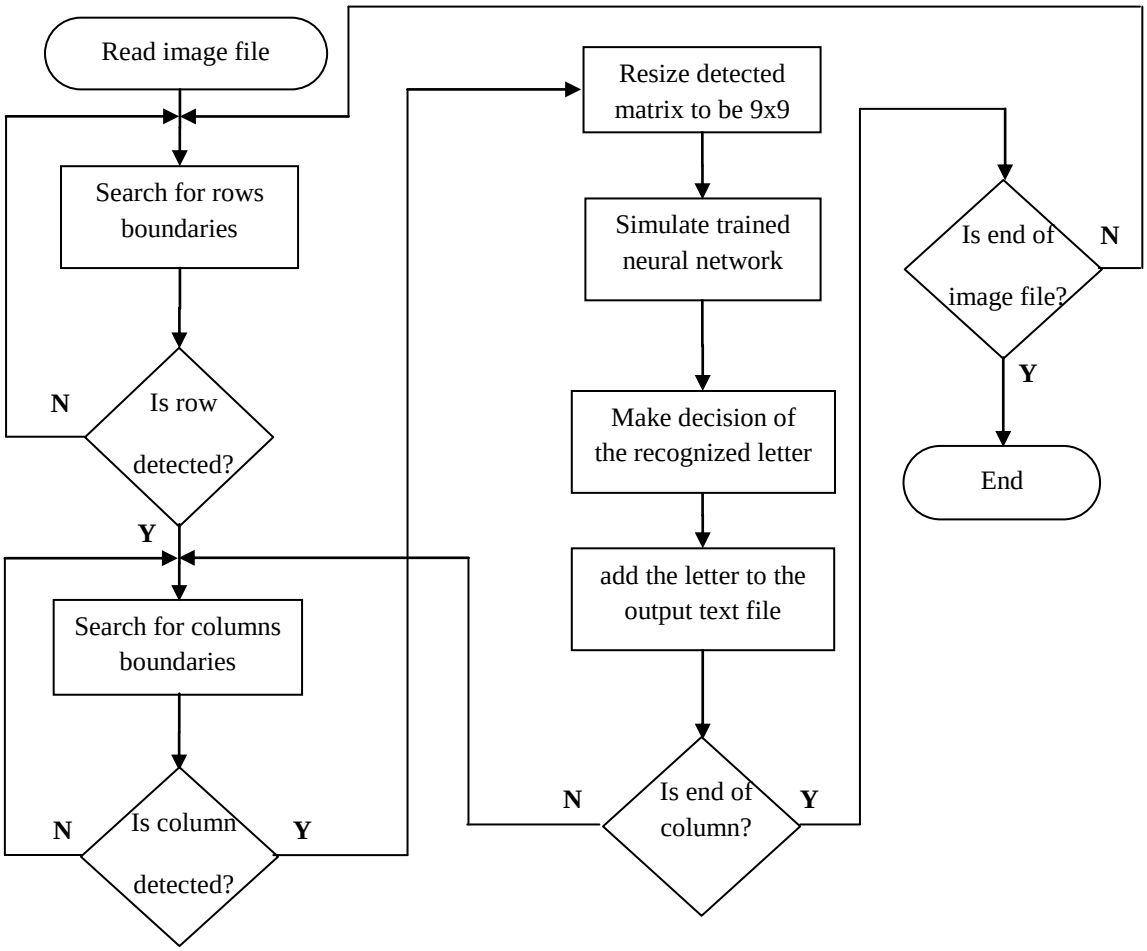

Fig. 7. Flow chart of hand written recognition system.

RESULTS AND CONCLUSIONS:

- A neural network is a powerful artificial intelligent system. It can be tuned to give better results by changing learning rate, number of hidden layers and number of hidden neurons, etc. The decision of putting the number of neurons in input and output layer are forced by the system.
- Selecting the ranges of input and output to be from one to minus one gives neural network wider range and better convergences in searching for optimal error cost function.
- Many training algorithms was tested in character recognition problem and the backpropagatoin algorithm gave encouraging results.
- Neural network can fully detect its learned letters and most of that shapes that is near to its trained letters. To improve the neural network detection, more patterns should be supplied into it.
- Neural network has fixed number of input layer neurons, therefore; action should be made in the input pattern to resize it to the 9×9 input matrix.

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