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Braille Identification System Using Artificial Neural Networks

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Abstract
The Braille system is a widely used method by the blind to read and write. Information technology revolution is changing the way Braille reading and writing, making it easier to use. All kinds of materials can be put into Braille representation, such as bank statements, bus ticket, maps, and music note.
In this paper, an artificial neural networks are designed to identify the number's image from (0-9) in Braille representation system. Networks will be trained and tested to be used for identify the scanned English number in Braille representation system. Some of the numbers are noised with some type of noise to simulate somehow the real world environment.
According to the experiment the result of the identification of number that written in Braille representation using Artificial Neural Networks the training accuracy was 97.1% and testing accuracy was 85%.

Introduction
Braille system requires the conversion of simple touch information into specific patterns. That cognitive process can be conducted by the sensory systems of the body, in normal peoples the identification process was accomplished routinely through the visual system, in blind people, the visual system is not used for that purpose[1].
Artificial Neural Networks will be trained and tested to be used for identifying the scanned English number that written in Braille representation system.
An artificial neural networks will be design to identify the number's image from (0-9). Some of the numbers are noised with some type of noise to simulate somehow the real world environment.
several authors have dealt with the usage of Artificial Neural Networks for OCR and character recognition [2].These researches include the recognition of English Arabic Characters [3]. Many authors have discussed detailed descriptions of methods for converting English letters into Braille and display characters on display terminals [4].
This paper has been reviewed Braille reading, which are used by blind people. Then reviewed the techniques used to read and write, then Contained a brief introduction of artificial neural networks and its structural, types of learning and backpropagation algorithm, which was used to train the system. Then explained clearly the system design steps starting with database collection, as well as the artificial neural network training and testing. Finally, the system has been reviewing the results of the training and testing process, then the research's conclusions and recommendations. In this paper an artificial neural networks system will be design to identify the numbers that written in Braille representation system.

Braille System
Braille is a system of raised dots that can be read with the fingers by people who are blind or who have low vision[2]. Braille system is not a language. Rather, it is a code by which many languages such as English, Arabic, Chinese and Spanish, may be written and read. Braille is used by thousands of people all over the world in their native languages, and provides a means of literacy for all[5][6].
It is written on special type of paper. They can write braille with the original slate and stylus or type it on a braille writer, such as a portable braille note taker, or on a computer that prints with a braille embosser[2].
Braille reading system based on small rectangular template called (cell), this cell contained all the symbol of letters, numbers and all the numerical symbol in any languages [6].
Braille method consists of arranged cells of raised dots, these dots are arranged in a grid. The cell consist of six dots arranged in two adjacent column as shown in figure 1.

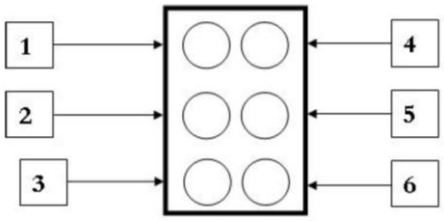

Figure 1: Braille Template

These points have some prominent or visible than others, according to a letter or written code. Read words and numbers from left to right and otherwise the method of reading the normal text.
Each reader has style of reading the text in terms of the use of the fingers and hands, there are those who read the fingering index and middle fingers of the right hand, and there are those who read with his index finger in both hands [7].

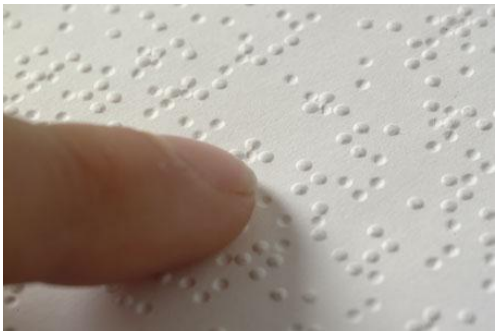

Figure 2: The Raised Dote of Braille Representation

The number and arrangement of the raised dots distinguish one number from another. In Braille alphabets the mappings (sets of numbers and symbols) vary from language to language for example in English Braille there are three levels of encoding: Grade 1 a letter_by_letter transcription used for basic literacy; Grade2 an addition of abbreviations and contractions; and Grade 3 various non-standardized personal short hands [8].

Braille Reading Techniques

A Braille reader must develop new skills, most important skill for braille readers is the ability to create smooth pressures when running one's fingers along the words. There are many different styles and techniques used the understanding and development of Braille system.

A study shows that blind could be read by using Braille system "fastest and best... by using the index fingers of both hands." Another important reading skill is to finish reading the end of a line with the right hand and finding the beginning of the next line with the left hand in the same time [9],[10].

Neural Networks

Artificial Neural Networks (ANNs) are a computer technique designed to simulate the way of human brain to do different tasks. Artificial neural networks can do that by a lot of parallel distributed processing unit (node). These unites is a mathematical models called (neurons). The neurons have the ability to process and store the information same as the biological neurons do. ANN consists of an interconnected group of artificial neurons and processes information [11][12].

Artificial Neural Network Structure

The most commonly used structure contained many layers, the first layer is the input layer, then one or more hidden layer, and finally the output layer. Each layer consists of at least one or more neurons. These neurons are connected by a connection line, which indicate the flow of information from one node to the next and from the input layer to the output layer through the network [11][13].

Artificial Neural Networks Learning

Artificial Neural Networks has impressive features is the ability to learn by adjusting the connections weighted between the neurons in the network layers.

There are different types of learning. The objective of learning process is to find a set of weight matrices which when applied to the network should map any input to a correct output. Below list of the most used learning types:

- **Supervised Learning**

In this type of learning the desired output for the network is also provided with the input while training the network. It is possible to calculate an error based on the differences between the target output and actual output of the network, which is used to make corrections of the network weights [14].

- **Unsupervised Learning**

Learning the neural network with this type, it only given a set of inputs without the output and the neural network's responsibility to find a pattern within the inputs provided [13].

- **Reinforcement Learning**

Reinforcement learning is similar to supervised learning in that some feedback is given, instead of providing a target output a reward is given based on how well the system performed. The aim of reinforcement learning is to maximize the reward the system receives through trial-and-error [11].

Backpropagation Algorithm:

Backpropagation (BP), is an abbreviation for "backward propagation of errors", this algorithm is the common algorithm of training artificial neural networks. The method calculates the gradient of a loss function with respect to all the weights in the network. The gradient is fed to the optimization method which in turn uses it to update the weights, in an attempt to minimize the error function [14].

In Backpropagation algorithm it must be know the desired output for each input value in order to calculate the error function gradient. It usually considered to be a supervised learning method. The backpropagation learning algorithm can be divided into two phases: [14]

Phase 1: Propagation

In the first feed forward propagation of a training pattern's input through the neural network in order to generate the output signal, then the backward propagation of the output signal through the neural network using the deltas (the difference between the targeted and actual output values) of all output and hidden neurons.

Phase 2: Weight update

After calculating the deltas from the first phase multiply its output delta and input activation to get the gradient of the weight. The sign of the gradient of a weight indicates where the error is increasing, this is why the weight must be updated in the opposite direction. Repeat phase 1 and 2 until the performance of the network is satisfactory and the error minimized.

Designing Braille Numbers identification system using Artificial Neural Networks

Artificial Neural Networks will be design to identify the English number from (0-9) that written in Braille representation system. The neural network should be able to classify noisy numbers as well as the numbers without noise.

Some of the number images are collected from the internet and some are scanned by using canon MP230 scanner device. Some of the number images are noisy with a type of filter by using Photoshop program version CS6 to insure that the neural network should be able to identify the true numbers and generate an output according to each number. All the images are converted to gray scale because of the easy to work with it using MATLAB program.

The output of the network is used to identify the corresponding Braille number according to the Braille rules.

System Design

A Neural Network is designed and trained to identify the Number that written in Braille representation. A neural network system for the Braille identification depends on Braille number images must deals with two basic problems: detection of the representation in the images, extraction of the essential features of the images such as the rising area to make the identification task. Threshold is a term used in signal processing and in image processing, a value that represents the minimum required processing to indicate if the value is less than the threshold are given a value 0, and if the value is greater than the threshold the output give her is 1. in the identification process the value 0 represent non identification otherwise identification.

Threshold was adapted to differentiate between the identified or unidentified numbers. The system includes the following steps as shown in figure 3:

1. Collect the number images.
2. Preprocessing (Resize, Filtering and Normalization).
3. Train (ANN).
4. Test (ANN).

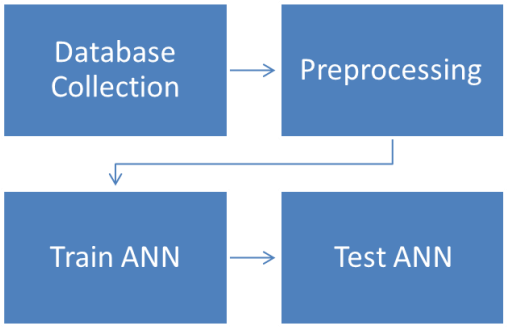

Figure 3: System Stages

The database that was used in this work is made up of scanned images of numbers. The size of the images are (70x115) pixel. The original database contains 10 images of the, representing 10 number (0-9).

In preprocessing stage firstly make all the number images in the same size. The database was expanded by using filter on the original image of each number. In the training process five images was used for each number, figure 4 shows an examples of the training images.

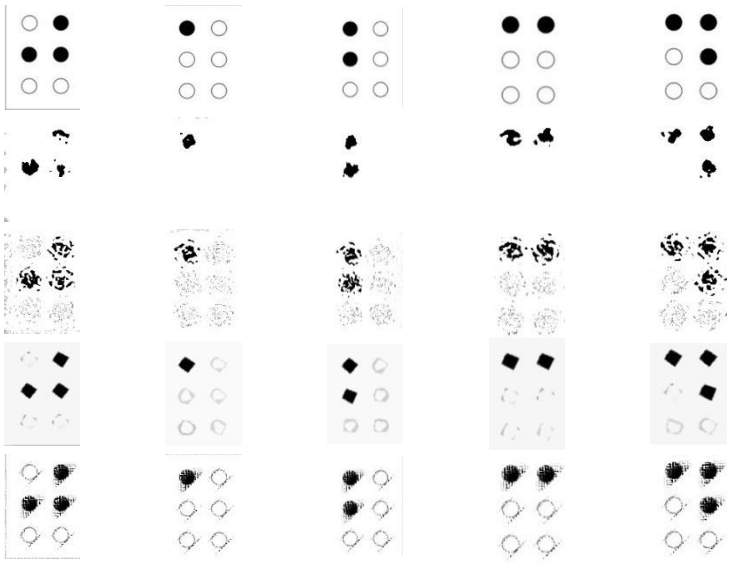

Figure 4: Examples of training images

In testing process three images for each number to test the identification accuracy for the Neural Networks as shown in figure below.

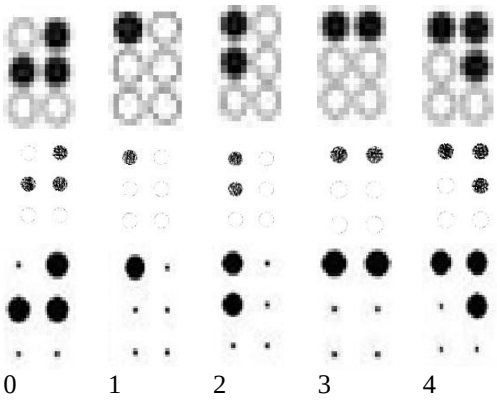

Figure 5: Examples of testing images

Normalization is the process of organizing the database by minimize data redundancy. The objective of Normalization is to isolate data so that additions, deletions, and modifications of an attribute can be made in small value. Normalization convert the range of the pixels values to a workable range. This is achieved by division each pixel value by 255, which is a linear transform that will maintain constant spacing between gray scales after transformation.

Several parameters that used to training artificial neural network such as Learning Rate, Momentum Factor, Minimum Error, Maximum Iterations, number of input neurons in the input layer, number of hidden layer and number of output neurons in output layer as shown in figure below.

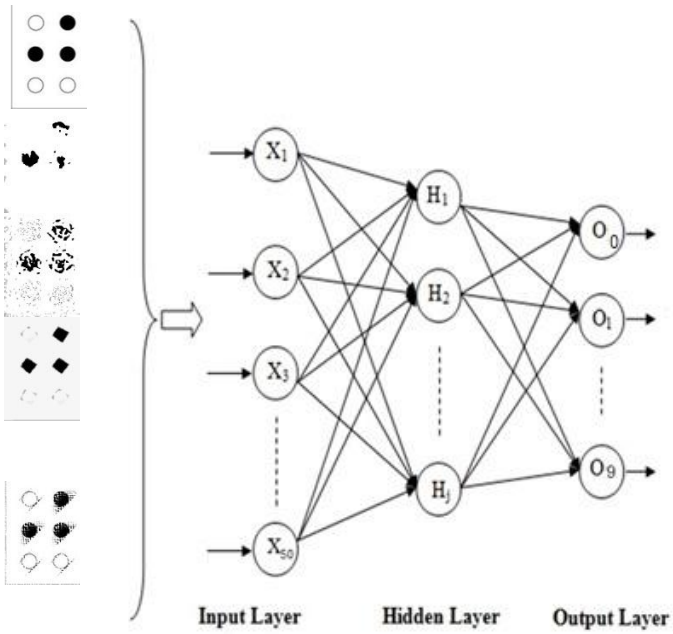

Figure 6: System Design

Experimental Results

In the result of the experiment the threshold value used to differentiate between the identified and not identified numbers was 80%. The neural networks system that designed using Backpropagation algorithm in training stage, The accuracies of training and testing was acceptable, it depends on the training algorithm of artificial neural networks. The number of images that were used in the experiment was: five images for training and three images for testing for each number.

Many different parameters used in the experiment to achieve the goal of the system to identify the number that was written in Braille representation. Below table show some parameters that used in the experiment:

Table 1: Training Parameters

No.	Parameter	Value
1	Learning Rate	0.004
2	Momentum Factor	0.3
3	Minimum Error	0.0034
4	Number of Iterations	2601
5	Maximum Iterations	5000
6	Number of Hidden layer	1

Changes in any value that listed in above table would be effect on the results of the training and testing process, where these values affect the training of the neural network and time spent on these process and

also the training and testing accuracy. Figure 7 shows the gradient of the training which represents the performance of the neural networks.

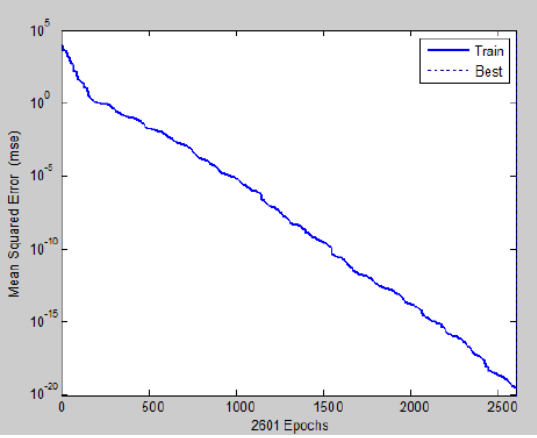

Figure 7: Neural Networks Performance

The identification results using the training image set yielded 97.1% accuracy which represented the average of all numbers in training, the testing image set has 85% accuracy.

According to the system threshold, the result that obtained from the experiment was successful. Table 2 shows the neural network training and testing accuracy.

Table 2 Neural Network Training and Testing Accuracy

Phase	Matching	percentage
Training	Accuracy	97.1%
Testing	Accuracy	85%

Conclusions

Designing and implementation of a system that identify the number written in braille representation using artificial neural network, the practical results has proven the success of this system, where many experiments was carried out and the result was very good.

Based on the experiment, it can be concluded that the using of artificial neural network in identification process is successful and very useful because of the easiest way to programming the network architecture and the processing time that takes to training and testing with any number of images, It can obtain high identification rate and accuracy.

As a future works it might be to expand the database to contain a letter and even to work with hole word and sentences that written in Braille representation.

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تمييز الارقام المكتوبة بطريقة برايل باستخدام تقنيات الشبكات العصبية الاصطناعية

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الملخص

طريقة برايل هي الطريقة الاكثر استخداماً من قبل المكفوفين على نطاق العالم للقراءة والكتابة. ان ثورة تكنلوجيا المعلومات هو جعل هذه الطريقة اسهل في الاستخدام للقراءة والكتابة. ان طريقة برايل ليست لغة وانما تمثيل لرموز وحروف أي لغة بطريقة معينة. جميع انواع المواد يمكن تمثيلها بطريقة برايل مثل البيانات المصرفية وتذاكر الحافلات والخرائط والمذكرات وغيرها.

في هذا البحث, سيتم تصميم نظام باستخدام الشبكات العصبية الاصطناعية للتعرف على الارقام (0–9) المكتوبة بنظام تمثيل برايل, سيتم تدريب واختبار الشبكة العصبية للتعرف على الارقام الانكليزية, بعض صور الارقام تم تشويهها بنوع او اكثر من الضوضاء لمحاكاة ما قد يواجه النظام في بيئة عمل اعتيادية.

بالاستناد الى نتائج التجارب التي تم اجراءها على النظام للتعرف على الارقام الانكليزية المكتوبة بتمثيل برايل وباستخدام تقنيات الشبكات العصبية الاصطناعية, كانت نسبة دقة عملية تدريب الشبكة العصبية هي 97.1% ونسبة الدقة لعملية الاختبار هي 85%.