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Leaves recognition system using a neural network

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Abstract

Leaf recognition has been gained an importance since the increment of intelligent applications in different platforms such as desktop and mobile. Each leaf contains unique distinct pattern on it that provides effective input for neural networks in order to recognize the type of the leaf correctly. In this paper, intelligent recognition system is presented to recognize and identify 27 different types of leaves using back propagation neural network and results show that the developed system is superior to recent researches with the recognition rate of 97.2%.

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Keywords:Intelligent systems; leaf recognition; back propagation; neural networks.

1. Introduction

The classification of plants is very important in grouping plants into different ranks and classes based on different classifiers or categories. It puts each group of plants having some common properties into classes. Also the classes are then divided into sub-classes and types to differentiate among the elements of the class. This classification is very important to help scientists to study the common behaviors and properties of the plants. Especially those plants used in the medicine or medical plants.[1]

In the past before the invention of digital cameras and computerized systems; people were using their own absolute experience in defining different types of medical plants. The risqué of using the wrong plant for medicine extraction increases with the lack of experience and can cause fatal error that can cause the death of some patients. The existence of digital devices and possibilities of computer vision has encouraged the botanists and computer scientists to develop computerized systems or semi automatic systems for plant classification or recognition based on

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different features. Different researches have treated the problems of the plant classification and mentioned different methods of recognition for these plants.[2]

The last century has seen a very great development in artificial intelligence and machine vision where a lots of pattern recognition and classification tasks were investigated by using automatic computer systems.[3]

Artificial neural networks have entered the race of pattern recognition and classification for decades due to their simplicity of implementation and ease of use; in addition to their flexibility for different applications and the high efficiency that they achieved. The development of digital processors has also encouraged the use of neural networks in many sciences[4,5,6]. Neural networks use mathematical equations to imitate the structural construction and functional principle of the biological brain. Neural networks implement a structure similar to human brain to learn the pattern among different elements and apply themselves based on the acquired knowledge. This knowledge is then applicable on other elements that may have the same pattern or not.

Neural network systems gain their knowledge and develop their experience over the time by using examples to reinforce the weights of connections between their neurons. They use the example and error in repetitive check and adaptation or rearrangement of themselves to suit the system they are trying to describe. This repetitive task is called training or learning of neural networks. Whenever the networks develop a correct relation between their input and output examples then they are called to be trained.

Several different researches had been performed by other researchers to recognize and identify different types of leaves. S. Gang Wu et al[7] used morphological features of leaves to recognize 32 different types of leaves and 90.3% of recognition rate was achieved. S. Prasad et al[8] performed experiments using SVM in order to recognize 23 types of leaves and 95% is obtained. A. Ehsanirad and S. Kumar[9] used gray level co-occurrence matrix to recognize 13 different types of leaves with 78.46% of recognition rate and J.S. Cope et al[10] used Gabor co-occurrences to recognize 32 plant leaves and 85.16% of recognition was achieved.

This paper concentrates on the employment of ANN system to classify different medical plants and differentiate among them using their leaves. Different leaves collected arbitrary from different medical plants and their images were taken using a digital camera. The images were then processed and used in the training of a neural network computer system. This paper also includes the methodology of the research and the different steps of it; starting by collecting the data base and ending with the testing stage. The implementation of the noise and processing of the images is an important stage in the recognition procedure. The processing of the images is done by using MATLAB which includes adding the noise to the photos in addition to resizing and changing the type of images to reduce processing expenses.

2. Methodology and the Structure of the System

The first step of the system is the capturing of a leave on the tree. The original image that is acquired, first converted to gray scale image and then scaled to 50x50 size to minimize the training time of neural network. After that, noise is added in order to create efficient and different input data for the neural network. Finally the resulting 50x50 pixel matrix is fed to input layer of the back propagation neural network. Thus, the network has input layer with 2500 neurons. After several experiments, it has been found the optimum range for the number of neurons for the hidden layers as 200 and 240 respectively. 27 output neurons were used in order to recognize 27 leaves types. Figure 1 describes the structure of design system.

2.1. Training Set

The training set contains 9 copies from each of the leaf images, giving us total 243 training samples. 9 Different noise types were added original images to train the network for different possible images that can be fed to it. Figure 2 shows example training data.

2.2. Test Sets

The test set contains three sets containing 4 noisy copies of each leaf image, giving us total 108 samples to test for each noise group. Figure 3 shows different levels of noisy test sets of leaves.

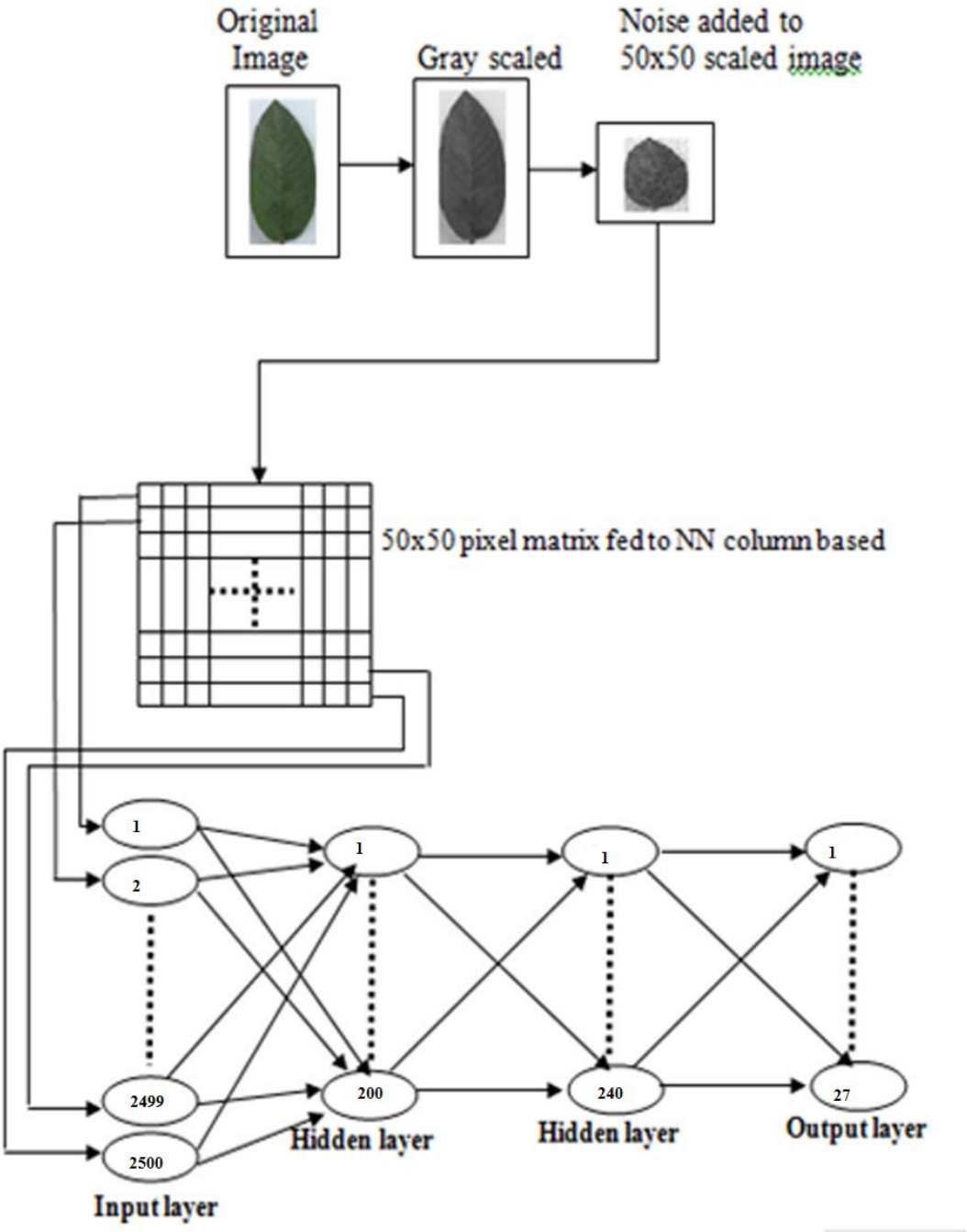

Fig. 1. General structure of the system.

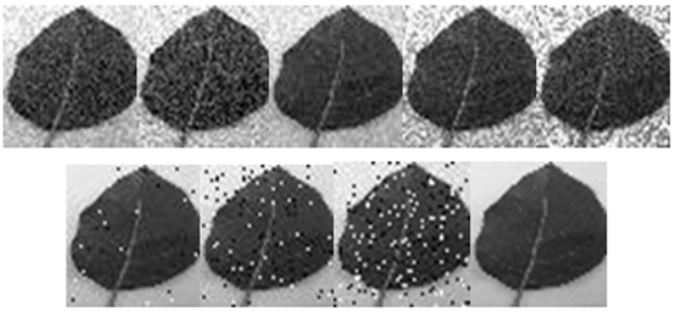

Fig. 2. Example 50x50 noisy training data for alligator pear.

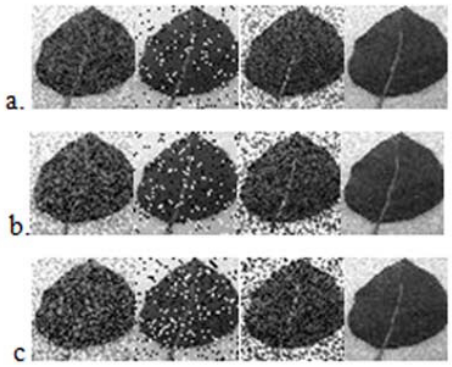

Fig. 3. (a) Test Set I; (b) Test Set II; (c) Test Set III.

3. Experiments and Results

Various experiments were applied on the sets of images until arriving suitable parameters of the neural network in the training process. In the training process of the neural network, 9 sequences of normal and noisy images were used. The first sequence displayed the normal images of the leaves. The other sequences were noised images Different examples of noises were used in the training like Gaussian and salt and pepper noise. Training parameters of neural network are shown in Table 1. A recognition ratio of 100% was obtained during the training and no images were misrecognized as expected. After the end of training, single repetition test was applied to check the ability of trained network to recognize other than the training sequence. The test was applied with three different groups of original images with different noise parameters. Each sequence contains 4 leaf images of each of the 27 trees. Table 2 displays the testing results of the Test Set I, Test Set II and Test Set III comparatively.

Table 1.Training parameters of neural network.

Parameters	Value
Number of input neurons	2500
Number of hidden neurons in hidden layer 1	200
Number of hidden neurons in hidden layer 2	240
Number of output neurons	27
Learning rate	0.05
Momentum	0.9
Training time	169 seconds
Max. epochs	1500
Target error	$5x10^{-7}$

Table 2. Test set results.

Set	Recognition Rate
Test Set I	97.2 %
Test Set II	91.7 %
Test Set III	79.6 %

4. Conclusions

Leaf recognition has been discussed in different scientific papers and researches. It can contribute strongly in the science of plants classification. This work has been carried out in the goal of introduction of leaves identification or classification using ANNs. The neural networks have proved their ability to give high efficiency in different applications. A leaf recognition process must discuss two basic points; the fundamental of the most important special features of the leaf, and the recognition of these leaves or the classification of them. In neural networks, the networks tries to classify the sets of leaves based on their color concentration without doing any mathematical or statistical studies. From the experiments carried out in this paper and the results obtained we conclude that the use of the neural network for leave recognition and plants classification was successful. The application of different noise on the leaves images has led to different recognition rates. Different experiments including training and test of networks have been carried out in this work. In the training process 9 set of images were prepared and fed to the neural network.

The process of back propagation has been started until an acceptable error was achieved. For the purpose of testing the obtained network's efficiency with different images out of the training sets; 3 different groups of images were prepared with different noises. These groups were divided into Test Set I, II, and III containing 4 sets of images each. These three groups were then fed to the network and their results were obtained. 100% out of the 243 training images were recognized correctly; whereas 104/108 images were recognized from the first group of images. That shows that the recognition rate was 97.2%. In the Test Set II group, 99 images out of 108 were recognized rightly with a rate of 91.7% which seems to be perfect under the high noise conditions. In the test of the Test Set III, the system was unable to recognize 22 images out of 108 images contained in the set. The recognition ratio was 79.6% in this experiment, which is considered very high under high noise ratio parameters of images. The results obtained in this work proved that the use of ANN for classification of plants based on the images of their leave is a promising idea. It is proving the ability to use neural networks for leave recognition tasks and for machine vision use in the classification process.

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