Artificial Neural Network Based Plant Species Identification

Rabiu Aliyu Abdulkadir
Department of Electrical Engineering,
Kano University of Science and
Technology, Wudil.
Kano, Nigeria
rabiukk@gmail.com

Khalipha Abubakar Imam,
Shamsu Idris Abdullahi
Department of Electrical Engineering,
School of Technology, Kano State
Polytechnic. Kano, Nigeria
khaliphaaimam@yahoo.com,
shamsuabdullahi114@gmail.com

Abubakar Isa
Physics Advanced Research Centre,
Sheda Sceince and Tecgnology
Complex, Abuja, Nigeria
abuabakarisa@yahoo.com

ABSTRACT—*in this research, we proposed an algorithm for the identification of plant leaves based on image processing techniques and artificial neural networks. Image processing techniques help in improving the quality of the images, and hence increase the performance of the identification process and reduce the rate of error. The processed images are used to train an artificial neural network (ANN) for the different plant types. After the training process, the network will be ready to classify and identify the different types of leaves even if there were not presented before. In order to validate the algorithm an experiment is conducted on ten different plant species. The experimental result indicated that the proposed algorithm is able to classify the leaves at high speed with high accuracy.*

KEYWORDS—**plant identification, image processing, ANN.**

INTRODUCTION

Plant leaves identification is an important process with application in different fields, including medicinal plant collection and classification, and study of the environmental life. Manual identification of plant species using their leaves and stems is a very difficult task that requires a lot of experience in addition to huge books that shows the different types of plants and their leaves. However, the increasing capabilities of the new cameras and mobile phones gives opportunity for picturing plant leaves and using automatic ways to identify them. The majority of the existing algorithms are based on segmentation technique [1]. The main disadvantage of these approaches is that any error in the segmentation will lead to a wrong identification of the leaf.

In this work, we proposed a novel plant identification algorithm that utilizes image processing techniques to enhance the quality of the image, and employ the learning capability of artificial neural networks for identification. These improved the performance of the identification process and reduce the rate of error, in addition to flexibility and reliability. An experiment is conducted in order to validate our algorithm.

VII. DIGITAL IMAGE PROCESSING

Digital image processing is described as processing of digital images by means of a digital computer [2]. Many methods of image processing are available and have been successfully utilized in many applications such as; Intelligent eye tumor detection system [3], face recognition, finger print recognition, automatic traffic control systems and video surveillance [4, 5]. For simplicity some of the important DIP processes that are related to our work will be presented here. This includes image representation, image filtering, and image segmentation.

A. Digital Image Representation

When an image is captured on a digital camera, it captures the analogue information of the image and transforms it to tinny blocs of digital values known as pixels. Digital images can be stored in different formats as it is well known. RAW images, JPEG, PNG, JIF, and BMP images are all types of images represented using different compression methods [6]

B. Edge Detection in Digital Images

Edge detection is the process in which significant object properties in digital images are being detected and captured. These properties include discontinues lines in the characteristics of the object. The main aim of edge detection is to identify and separate these variations in the property of objects within the image. It is very useful in detecting and identifying the region of interest (ROI) in an image. Famous edge detection techniques include:

Sobel edge detection: Sobel operator applies a two dimensional space gradient calculation to highlight the high frequency regions in the spatial domain. It finds the gradient of each pixel in gray scale images. Sobel edge detection method employs two kernels of 3x3 matrixes. The two matrixes are shown as follow.

$$G_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \tag{1}$$

$$G_y = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} \tag{2}$$

The magnitude of the gradient of the image can be found by

$$|G| = \sqrt{G_x^2 + G_y^2} \tag{3}$$

Sobel edge detection is less affected by the image noise [7].

- **Prewitt edge detection:** Prewitt edge detection is similar to the Sobel method as it also uses similar

kernel to find the gradient in an image. The kernel in Prewitt method is isotropic as shown in the next equations defining the horizontal and vertical kernels [8].

$$G_x = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix} \qquad (4)$$

$$G_y = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix} \qquad (5)$$

- **Canny edge detection:** Canny edge detection is one of the most common edge detection algorithm employed to increase the signal to noise ratio and identify the different features of the image. Generally, Canny edge detection algorithm is composed of several steps; At the beginning, the image is smoothed to remove noise and blur, followed by filtering using Gaussian filter. Finally, the gradient of the image is obtained. The more the change in the image pixels the higher the gradient is. This fact is used to identify the sharp changes in the mage pixels. Canny edge detection uses threshold to eliminate the unwanted regions of the image and highlight the regions of interest (ROIs) [9].

- **Robert's edge detection:** The Robert operator is used to approximate the gradient of image using discrete differentiation. Robert mask is a 2x2 kernel that convolve with the whole image using its horizontal and vertical versions [8].

C. Wiener Filter

Wiener filter is an adaptive filter type which uses the error minimization formulas to reject the noise from images. It is based on the mean squared error approximations. It is considered as a frequency filter that can be used with discrete Fourier transform of the image. The reconstruction of the image is carried out by applying the inverse version of discrete wavelet transform. Wiener filter performs greatly in many applications of image filtering and restoration [10].

ARTIFICIAL NEURAL NETWORK

An Artificial Neural Network (ANN) is an information processing tool that is motivated by the biological nervous system such as the brain. Artificial Neural Networks (ANN) are widely used to approximate complex systems that are difficult to model using conventional modelling techniques such as mathematical modelling. The most common applications are function approximation (feature extraction), and pattern recognition and classification. There is no exact available formula to decide what architecture of ANN and which training algorithm will solve a given problem [11]. The best solution is obtained by trial and error. One can get an idea

by looking at a problem and decide to start with simple networks; going on to complex ones till the solution is within the acceptable limits of error. There are different neural network architectures. The basic architectures include multi-layered feed-forward networks (Figure 1) that are trained using back-propagation training algorithms.
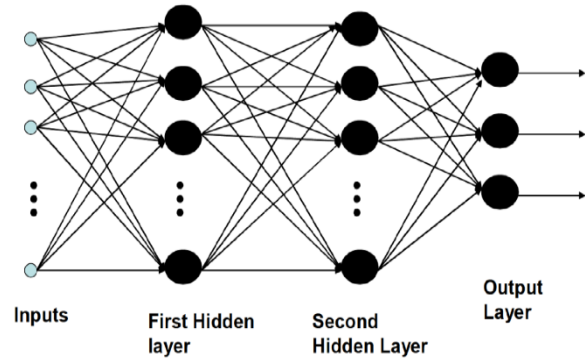

Figure 1: Multi-layered feed-forward neural network

SYSTEM DESIGN

D. Dataset Description and Pre-processing

The dataset is composed of approximately 200 leaves images of 10 different plants. These images were all taken as jpg format. The sample images are shown in Figure 2. All the images were obtained in RGB format and converted to gray scale format to make it more suitable for processing. The next step will be to scale down these images so that it will be less size to be fed to neural networks.

The data set file is saved in the matlab folder as plantleaves.mat. The file is loaded using the command loadplantleaves; in the code. This command uploads the file and includes all the variables setup in the current workspace. The data is divided into training, testing and validation. Once the network has been trained, it has to be tested on data that it has not seen before in order to determine the performance of the trained network.

Figure 2: Sample of the used plant leaves

NCEC 2018: Department of Communications Engineering, Ahmadu Bello University, Zaria, Nigeria, 17th – 19th October 2018

40

E. *Algorithm Flowchart*

The flowchart of the overall algorithm is presented in Figure 2. The algorithm is made up of 3 fundamental components; data pre-processing, image processing (edge detection and filtering), building the neural network.

Figure 3: Flowchart of the proposed work

SIMULATION RESULT

The simulation was carried out using Intel ® core ™ i5-4200U CPU @ 2.29 GHz PC with 4GB RAM, windows 10, 64-bit OS, and MATLAB 2016b software.

Three different methods of edge detection were applied in this work to test the effect of each of them on the efficiency of our system. Figure 4 shows the results of the edge detection. Sobel method has given the best region of interest detection and hence used as the main edge detection method in this work.

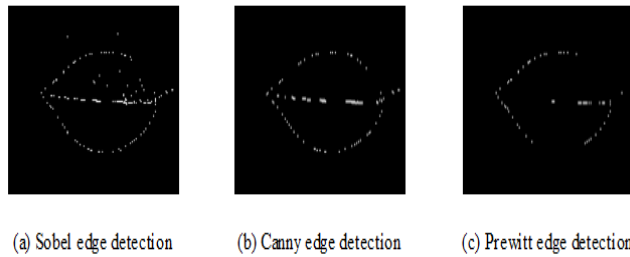(a) Sobel edge detection   (b) Canny edge detection   (c) Prewitt edge detection

Figure 4: Edge detection results

Figure 5 presents the results obtained from the application of the different image processing techniques. The first image (a) is the original image in RGB format, (b) is the gray scale converted image, while (c) is the filtered image using Wiener filter and (d) is the segmented version of the leaf showing the edges of the leaf.

(a) Original Image   (b) Gray Image

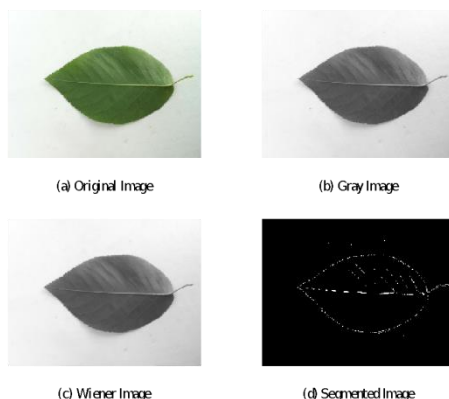(c) Wiener Image   (d) Segmented Image

Figure 5: Image processing result

The structure of the used artificial neural network is presented in Figure 6. The network consists of 1 input layer, three hidden layers, and 1 output layer. Hidden layers are all

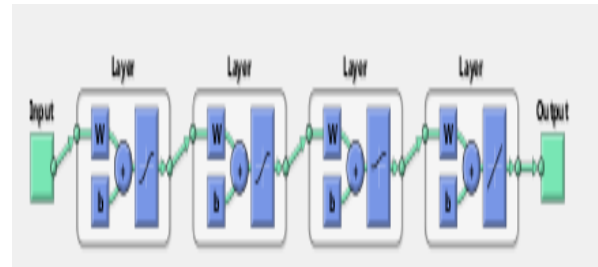sigmoid transfer functions while the output layer is a linear transfer function.

Figure 6: Structure of the ANN

TABLE I. TABLE I. ANN PARAMETERS

Parameter	Value
Input neuron size	2500
Output neuron size	10
Hidden neuron 1	250
Hidden neuron 2	280
Hidden neuron 3	200
Learning rate	0.01
Momentum factor	0.1
Epochs	2800
MSE	0.000002

The performance of the developed network was assessed by testing the network with a different 50 samples of the plant leaves data (5 from each plant). The parameters of the successfully trained neural network are presented in Table I. The successfully trained neural network classified the testing data correctly; hence, 100% recognition is achieved.

CONCLUSION

An algorithm has been developed for the identification of plant leaves based on image processing techniques and artificial neural networks. The simulation is by writing a matlab code that uses matlab commands. The performance of the developed network was evaluated by testing the algorithm with different samples of the plant leaves image dataset. The successfully trained neural network classified the testing data correctly; indicating 100% recognition.

REFERENCES

1. Amin, A. H. M., and Khan, A. I, "One-shot Classification of 2-D Leaf Shapes Using Distributed Hierarchical Graph Neuron (DHGN) Scheme with k-NN Classifier," in Procedia Computer Science, Vol. 2, pp.84–96, 2013.
2. R. C. Gonzalez and R. E. Woods, Digital Image Processing, New jersey: Parentice Hall, 2008.
3. K. Dimililer, Y. K. Ever and H. Ratemi, "Intelligent eye tumour detection system," in Procedia Computer Science 102 (2016) 325 – 332, Austria, 2016.

4. M. J. Kumar, D. G. R. Kumar and R. V. K. Reddy, "REVIEW ON IMAGE SEGMENTATION TECHNIQUES," International Journal of Scientific Research Engineering & Technology, vol. III, no. 6, p. 2278 – 0882, 2014.

5. Y. K. Dilpreet Kaur, "Various Image Segmentation Techniques: A Review," International Journal of Computer Science and Mobile Computing, vol. III, no. 5, p. 809 – 814, 2014.

6. Boran Sekeroglu. (2004). *Intelligent Banknote Identification System (IBIS)*. Near East University.

7. Robert, F., Simon, P., Ashley Walker; & Wolfart, E. (2003). Hypermedia Image Processing Reference. Retrieved from http://homepages.inf.ed.ac.uk/rbf/HIPR2/sobel.htm

8. Chaple, G. N., Daruwala, R. D., & Gofane, M. S. (2015). Comparisions of Robert, Prewitt, Sobel operator-based edge detection methods for real time uses on FPGA. In *2015 International Conference on Technologies for Sustainable Development (ICTSD)* (pp. 1–4).

9. Shen, D., & Tang, Z. (n.d.). Canny Edge Detection Algorithm for Image Processing Using FPGA. In *Second International Conference on Electric Information and Control Engineering* (pp.419–442).Washington. https://doi.org/10.1109/ICEICE.2012.110

10. Khajwaniya, K. K., & Tiwari, V. (2015). Satellite image denoising using Weiner filter with SPEA2 algorithm. In *9th International Conference on on Intelligent Systems and Control* (pp. 1–6). India. https://doi.org/10.1109/ISCO.2015.7282324

11. R.A.Abdulkadir1, K. A. Imam and M. Jibril, "Simulation of Back Propagation Neural Network for Iris Flower Classification," American Journal of Engineering Research (AJER), vol. 6, no. 1, pp. 200-205, 2017.

NCEC 2018: Department of Communications Engineering, Ahmadu Bello University, Zaria, Nigeria, 17th – 19th October 2018

42