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Automated Tool for Plant Leaf Classification Using Morphological Features

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Abstract: ***Our planet is blessed with various species of fauna and flora. It's well known that plants play a crucial role in preserving the earth's ecology and environment by maintaining a healthy atmosphere and providing sustenance and shelter to innumerable insect and animal species. Plants are also important for their medicinal properties and as alternative energy sources like bio-fuel. Today as many types of plants are at the brink of extinction. In our day to day life herbal plays vital role on human physic maintenance. Plant classification has a broad application perspective in agriculture medicine and is especially significant to the biology diversity research. In recent time's computer vision have been successfully applied towards automated systems of plant cataloguing. The proposed system tries to bring atomization in the process of plant leaf classification such that without any precious knowledge of the leaf species, we are trying to detect the leaf. This will help the botanists in their study and speed up the process of identifying the species of plant. India is enriching source of plant species which is the base of 'Ayurveda' so the classification and identification of various plant species is one of the important phase. Our idea is to develop an automated tool which would detect and classify the plant leaf species after comparing with the trained sets. These trained sets are used by Artificial Neural Network (ANN) after image processing. The Neural Network would be trained for detection of edge and vein analysis. Earlier atomization was difficult, but now due to drastic development in technological field it is possible in just few steps. This paper proposes the automated tool for plant leaf recognition of leaf its digital image. Manual identification requires prior knowledge of species and is a lengthy process, thus the atomization technique helps to speed up the traditional method of plant leaf classification. Also the paper compares different methods used in plant leaf classification.***

Keywords: Image preprocessing, Edge Detection, Vein Detection, Artificial Neural Network.

1. Introduction

Plants are vitally important for environmental protection, it is more important to identify and classify them properly [3]. World Health Organization estimates that 80% of people in Asia and Africa rely on herbal medicine due to the fact that they are gaining popularity worldwide as they are safe to human health and affordable. Many of them carry significant information for the development of human society [1]. Leaves of same species also have variation in there shapes and moreover leaves of different species may have a same size because of the complex nature of leaves. So we need some hierarchy in this process. India is full of variety of plant species, many of which are unknown at thus their identification is very important in the field of Ayurveda. One of the difficulty, in the field of Ayurveda is knowledge dies with the Expert, but keeping technology at the center they can last long for long time and also there is stress relief as we are not required to memorize all the different types of plant species. For retrieving target species name in the proposed system, modules designed will be Image preprocessing, Edge Detection, Vein Detection [3], Neural Network [2], Leaf Classification [4]. A leaf from an unknown species of plant will be the input to the proposed system. The system then

Segments the leaf image from its background, computes the morphological feature [1] representation used for matching, and then displays the similarity percentage as computed. The leaf image will be captured on a plain contrast background to reduce the complexity of the segmentation algorithm and give better performance [7].

2. Previous work

Many methodologies [6] have been developed in automated fashion for plant leaf identification, most of them used shape modeling algorithm for contour detection. As contour detection is a heart of the object detection, It is the most important and preliminary phase in image processing so it, acts as a strong classifier. Moment invariant method uses 7 moments that describe shape, unchangeable to scaling, translation and rotation. This method needs more computation. Then Centroid-Radii method uses normalized radius and uniform distribution of angle at its center [6]. This method is faster as it uses predefined number for angle distribution and use simple radius calculation but, the method can fails to highly irregular leaf image. Adaptation in these methods is Binary Super-positioning method [6]. It is fast and easy from implementation point of view but it requires higher data set and moreover at the time of image capture, the image should be strictly at the center. Considering these features and constraint, we can use it for elimination of species which will not match with the proposed trained data set. Canny algorithm is also one of the best algorithms for edge detection, which is used for removal of noise. Additionally, few techniques have used some texture based features and color based features as to improve the accuracy of the detection.

As shown in Table 1. The literature survey depicts the advantages and disadvantages of various classification techniques.

Table1. Literature survey of various classification techniques

Author/ Publications	*Title*	*Classification Basis*	*Classifiers*	*Advantages*	*Disadvantages*
[1]Vishakha Metre, Jayshree Ghorpade IJCSN-June 2013.	Texture Feature Extraction for Identification of Medicinal Plants and Comparison of Different Classifiers	Texture Detection	SGD, kNN, SVM, D, ET, and RF.	No use of preprocessing increases the classification performance.	As no preprocessing, no Noise consideration.
[2] Abdul Kadir et. al. IJCTT-2011	Leaf Classification using shape, color, and texture features	Shape, Vein, Color, and Texture.	Probabilistic neural network (PNN).	Due to several features system performance is better	Lots of mathematical calculation.
[3] Mohsen Sharifi, Mahmoud Fathy, Maryam Tayefeh Mahmoudi IEEE.-2002	A Classified and Comparative Study of Edge Detection Algorithms	Edge Detection	Gaussian Edge Detector	Using probability for finding error rate, Localization and response, Improving signal to noise ratio.	Complex Computations, False zero crossing, Time consuming
[4] H. Fu and Z. Chi IEE-2006	Combined thresholding and neural network approach for vein pattern extraction from leaf images	Vein Detection	Trained ANN Classifier	Determines the vein pixel darker than background which improves performance of ANN classifier.	Lots of mathematical calculation.
[5] Wei Jiang, Cui-cui Ji, Hua Zhu IEEE-2009	Fractal Study on Plant Classification and Identification	Fractal Dimensions	Pixel-covering method	Nervure details analysis was incorporated into the whole classification system to make It more accurate.	Won't apply when pixel number are less

3. Proposed system

Our system is based on image processing which finds an unknown leaf species without any previous knowledge, which is useful for any layman. The basic factors for

identification of species are Contour, Vein, and Neural Network.

Step1: Image Acquisition

First, we capture leaf image by digital device in RGB form. We have ready data set for comparing that unknown images [7, 9].

Step 2: Image Preprocessing

Image processing is the enhancement of image i.e., processing an image so that the results are more suitable for a particular application [9]. Processing an image involves following phases:

i. Conversion of original captured image into grayscale image [2].
ii. Convert that image into Binary image.
iii. Smoothening of that image for improving contrast of image.
iv. Removing unwanted noise for segmentation of image.

Step3: Edge Detection

The propose system finds the specific tokens which represents that portion of the image where transfer of lower to higher pixel intensity occurs. These tokens are used for neural network calculations. Prewitt edge detection produces an image where higher grey-level values indicate the presence of an edge between two objects. The Prewitt Edge Detection filter computes the root mean square of two 3x3 templates.

The Prewitt edge detection filter uses the two 3x3 templates i.e. X and Y to calculate the gradient value, represented in equation (3)

$$\begin{pmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{pmatrix} \qquad \begin{pmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{pmatrix}$$

X Y

$$\begin{pmatrix} a_1 & a_2 & a_3 \\ a_4 & a_5 & a_6 \\ a_7 & a_8 & a_9 \end{pmatrix}$$

As shown above the 3x3 image window consists of $a_1 \ldots a_9$ grey levels of each pixel in the filter window.

$$X = -1*a_1 + 1*a_3 - 1*a_4 + 1*a_6 - 1*a_7 + 1*a_9 \quad \ldots (1)$$

$$Y = 1*a_1 + 1*a_2 + 1*a_3 - 1*a_7 - 1*a_8 - 1*a_9 \quad \ldots (2)$$

$$\text{Prewitt gradient} = SQRT(X*X + Y*Y) \quad \ldots (3)$$

As shown in equation (3) the Prewitt gradient is calculated using equation (1) & (2).

All pixels are filtered. In order to filter pixels located near the edge of an image, edge pixels values are replicated to give sufficient data. The cosines and sinus angles of the shape represents the criteria's of a recognition pattern which are used for creation of tokens for the leaf image.

Step4: Vein Structure Detection

After detecting edge we extract vein structure by setting proper threshold while converting the color image to binary image. We include this part because there is possibility of two leaf species having very much similar shape [3]. So to distinguish between them we consider veins part of the leaf.

Step5: Neural Network

Another main part of this work is the integration of a feed-forward back propagation neuronal network. As described earlier the inputs for this neural network are the individual tokens of a leaf image, and as a token normally consists of a cosines and sinus angle, the amount of input layers for this network are the amount of tokens multiplied by two. Figure1 as shown below should give you an idea of the neuronal network that takes place in the application.

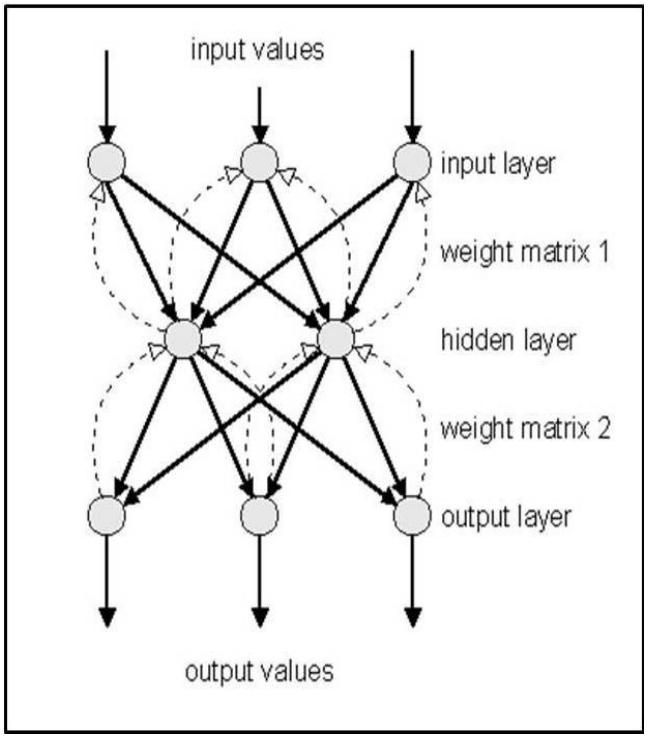

Figure1. Neural Network [10]

The implemented networks also just have one input, hidden and output layer to simplify and speed-up the calculations on that java implementation [8]. To fill the input neurons of the network, we use the previous calculated leaf tokens like discussed earlier. The number of output neurons is normally specified by the amount of different species because we use an encoded form to specify the outputs. All other behavior of the network is specified by the normal mathematical principal of a back propagation network.

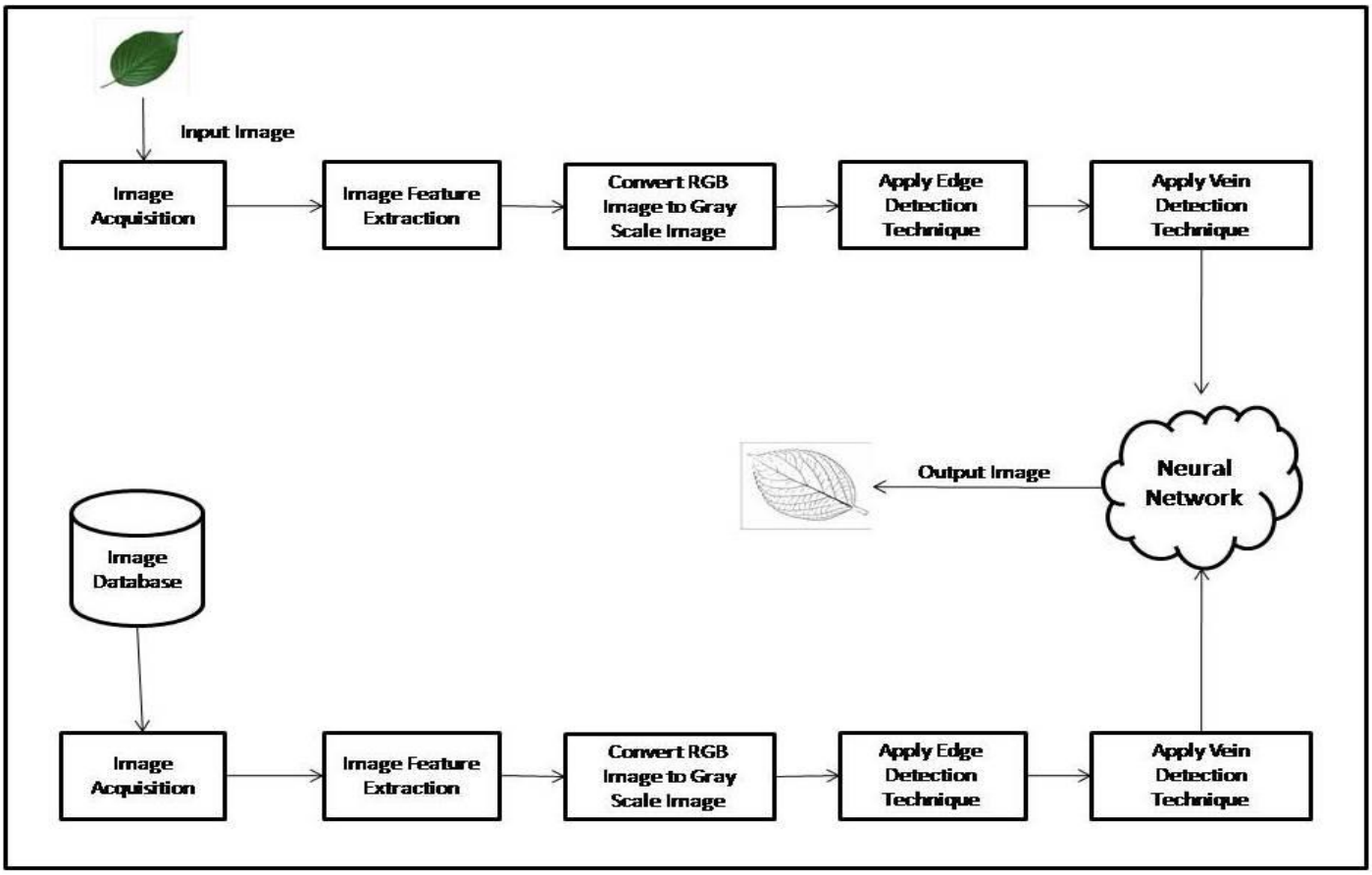

Figure2. Block Diagram of Proposed System for Plant Leaf Classification

4. Conclusion

The proposed work helps us to detect the known herbal species with the help of image processing and algorithms based on edge detection and vein structure to get higher

percentage similarities between the two leaves to improve medication process of Ayurveda's. Also an overview of literature on various techniques that can be used for plant classification is discussed.

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