Automatic Methods for Classification of Plant Diseases using Back-Propagation Neural Networks

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Abstract - *The project presents leaf characteristics analysis using image processing techniques for automated vision system used at agricultural field. In agriculture research of automatic leaf characteristics detection is essential one in monitoring large fields of crops, and thus automatically detects symptoms of leaf characteristics as soon as they appear on plant leaves. The proposed decision making system utilizes image content characterization and supervised Classifier type of neural network. Image processing techniques for this kind of decision analysis involves preprocessing, feature extraction and classification stage. At Processing, an input image will be resized and region of interest selection performed if needed. Here, color and texture features are extracted from an input for network training and classification. Color features like mean, standard deviation of HSV color space and texture features like energy, contrast, homogeneity and correlation. The system will be used to classify the test images automatically to decide leaf characteristics. For this approach, automatic classifier NN be used for classification based on learning with some training samples of that some category. This network uses tangent sigmoid function as kernel function. Finally, the simulated result shows that used network classifier provides minimum error during training and better accuracy in classification.*

***KeyWords*: Back-Propagation Neural Networks; Clustering; Feature extraction; Image processing; Particle swarm optimization**

1. INTRODUCTION

Agriculture helps us to get sufficient and necessary food for a living and it has a big contribution to the nation's economic growth. Countries which are highly dependent on agricultural are India, China, US, Brazil, France, Mexico, and Japan. Therefore, to protect these countries from economical breakdown plant disease detection at an early stage is very important. When a plant becomes infected by any disease, it spreads all over the plants; branches of plants suddenly wither, stop growing, and die. A simple solution to control this drastic damages is to hire a group of experts who will continuously monitor the plants with naked eyes but this costs high and the process is time-consuming and inaccurate. Instead, automatic detection of diseases by just observing the symptoms on the leaves is more meaningful, time and cost efficient and accurate. The microorganisms that infect plants are bacteria, fungus, protozoa, and virus. Viruses are the strongest among all the pathogens. The viral infection prevents the plant's growth, makes the leaves yellowish, wilted and molted. Bacterial wilt, Crown gall, and Fireblight are some of the examples of bacterial diseases. Anthracnose, Downy mildew, Powdery mildew, Black spot, and Late blight are examples of fungal diseases. Fungi cause a significant amount of damages to the plants; agreeing to a survey 80 % plant diseases are caused by the fungus.

1.1 PROPOSED SYSTEM

Automatic methods for classification of plant diseases also help taking action after detecting the symptoms of leaf diseases. The proposed work presents a Back-propagation Neural Network model based method for leaf disease detection and classification. The dataset contains 50 images of leaves with four symptoms of diseases. We have modeled a Back Propagation Neural Network for automatic feature extraction and classification.

2. TECHNOLOGIES USED

MATLAB

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects. Today, MATLAB uses software developed by the LAPACK and ARPACK projects, which together represent the state-of-the-art in software for matrix computation.

2. 1 The MATLAB System

The MATLAB system consists of five main parts:

1. Development Environment
2. The MATLAB Mathematical Function Library
3. The MATLAB Language
4. Handle Graphics®
5. The MATLAB Application Program Interface (API)

1. Development Environment

This is the set of tools and facilities that help you use MATLAB functions and files. Many of these tools are graphical user interfaces. It includes the MATLAB desktop and Command Window, a command history, and browsers for viewing help, the workspace, files, and the search path.

2. The MATLAB Mathematical Function Library

This is a vast collection of computational algorithms ranging from elementary functions like sum, sine, cosine, and complex arithmetic, to more sophisticated functions like matrix inverse, matrix eigenvalues, Bessel functions, and fast Fourier transforms.

3. The MATLAB Language

This is a high-level matrix/array language with control flow statements, functions, data structures, input/output, and object-oriented programming features. It allows both " programming in the small& quot; to rapidly create quick and dirty throw-away programs, and " programming in the large& quot; to create complete large and complex application programs.

4. Handle Graphics®

This is the MATLAB graphics system. It includes high-level commands for two-dimensional and three-dimensional data visualization, image processing, animation, and presentation graphics. It also includes low-level commands that allow you to fully customize the appearance of graphics as well as to build complete graphical user interfaces on your MATLAB applications.

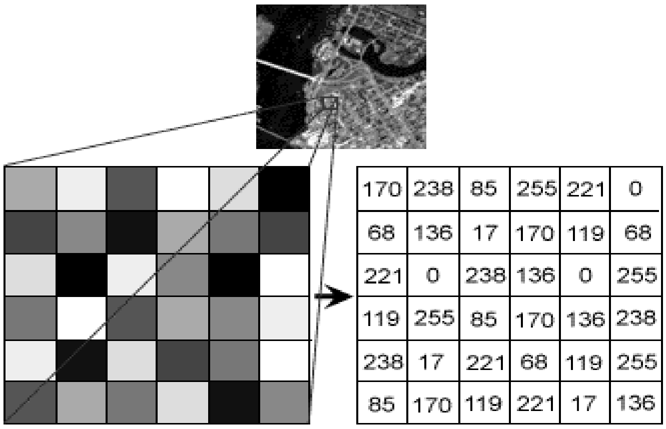
5. The MATLAB Application Program Interface (API)

This is a library that allows you to write C and FORTRAN programs that interact with MATLAB. It include facilities for calling routines from MATLAB (dynamic linking), calling MATLAB as a computational engine, and for reading and writing MAT-files.

3. METHODOLOGY USED

IMAGE PROCESSING

Digital image processing, the manipulation of images by computer, is relatively recent development in terms of man's ancient fascination with visual stimuli. In its short history, it has been applied to practically every type of images with varying degree of success. The inherent subjective appeal of pictorial displays attracts perhaps a disproportionate amount of attention from the scientists and also from the layman. Digital image processing like other glamour fields, suffers from myths, mis-connect ions, mis-understandings and mis-information. It is vast umbrella under which fall diverse aspect of optics, electronics, mathematics, photography graphics and computer technology. It is truly multidisciplinary endeavor ploughed with imprecise jargon.



Several factor combine to indicate a lively future for digital image processing. A major factor is the declining cost of computer equipment. Several new technological trends promise to further promote digital image processing. These include parallel processing mode practical by low cost microprocessors, and the use of charge coupled devices (CCDs) for digitizing, storage during processing and display and large low cost of image storage arrays.

4. FUNDAMENTAL STEPS IN DIGITAL IMAGE PROCESSING:

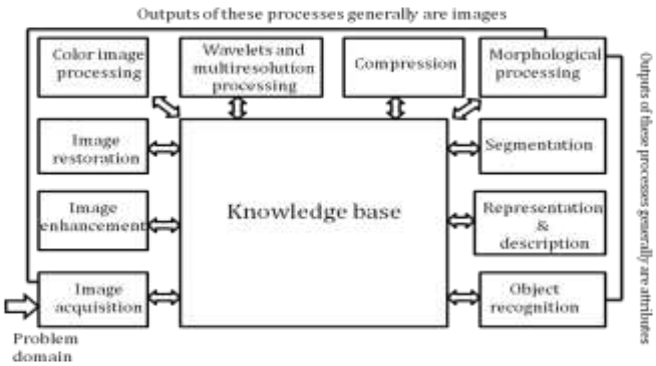


Fig:STEPS IN DIGITAL IMAGE PROCESSING

4.1 Image Acquisition:

Image Acquisition is to acquire a digital image. To do so requires an image sensor and the capability to digitize the signal produced by the sensor. The sensor could be monochrome or color TV camera that produces an entire image of the problem domain every 1/30 sec. the image sensor could also be line scan camera that produces a single image line at a time. In this case, the objects motion past the line.

FIG: IMAGE ACQUISITION

4.2 Image Enhancement:

Image enhancement is among the simplest and most appealing areas of digital image processing. Basically, the idea behind enhancement techniques is to bring out detail that is obscured, or simply to highlight certain features of interesting an image. A familiar example of enhancement is when we increase the contrast of an image because "it looks better." It is important to keep in mind that enhancement is a very subjective area of image processing.

FIG: IMAGE ENHANCEMENT

4.3 Image restoration:

Image restoration is an area that also deals with improving the appearance of an image. However, unlike enhancement, which is subjective, image restoration is objective, in the sense that restoration techniques tend to be based on mathematical or probabilistic models of image degradation.

FIG: IMAGE RESTORATION

4.4 Color image processing:

The use of color in image processing is motivated by two principal factors. First, color is a powerful descriptor that often simplifies object identification and extraction from a scene. Second, humans can discern thousands of color shades and intensities, compared to about only two dozen shades of gray. This second factor is particularly important in manual image analysis.

FIG: Color image processing

4.5 SEGMENTATION:

Segmentation procedures partition an image into its constituent parts or objects. In general, autonomous segmentation is one of the most difficult tasks in digital image processing. A rugged segmentation procedure brings the process a long way toward successful solution of imaging problems that require objects to be identified individually.

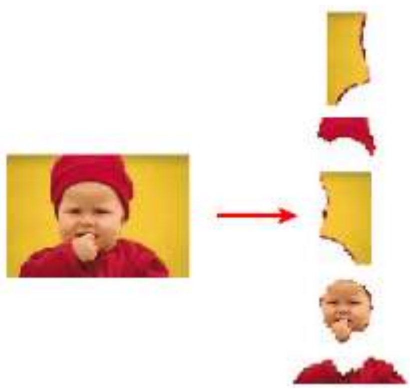


FIG: SEGMENTATION

5. MODULES:

(1) Pre-processing

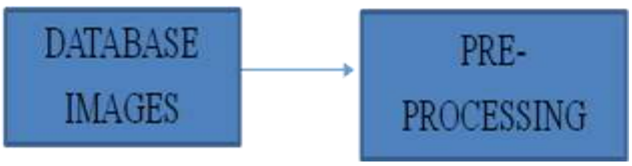
(2) GLCM feature extraction

(3) Image Training

(4) BPNN Classification

5.1PRE-PROCESSING:

Image pre-processing is the term for operations on images at the lowest level of abstraction. These operations do not increase image information content but they decrease it if entropy is an information measure. The aim of pre-processing is an improvement of the image data that suppresses undesired distortions or enhances some image features relevant for further processing and analysis task.



5.2 GLCM feature extraction

Texture features are extracted using Gray Level Co-occurrence Matrix (GLCM) Texture features calculated using GLCM are Contrast, Correlation, Entropy, Energy Homogeneity which are extracted from gray level co-occurrence matrix obtained from GLCM function.

(i) Contrast represents the number of local variations present in an image. It is calculated by the following equation:

Contrast= $\sum_{i,j=0}^{N-1}(i,j)^2\, C(i,j)$ (1) Here, C(i,j) is the probability of the presence of the gray levels i and j together.

(ii) Energy measures the amount of uniformity present in the image. It is measured by the following equation:

Energy= $\sum_{i,j=0}^{N-1} C(i,j)^2$ (2) (iii)Local homogeneity measures the similarity present in

between the distribution of GLCM elements and it's diagonal elements. It is defined by the following equation:

Local Homogeneity= $\sum_{i,j=0}^{N-1} C(i,j)\ /(1+(i-j)^2)$ (3) (iv) Entropy measures the amount of dissimilarity present in the GLCM matrix. It is calculated by the following equation: Entropy= (4) (5) correlation measures the joint propagation. It is calculated by the following formula

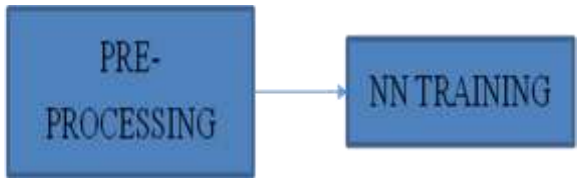
Correlation= (5)

$$\sum_{i,j=0}^{N-1} P_{i,j}\left[\frac{(i-\mu_i)(j-\mu_j)}{\sqrt{(\sigma_i^2)(\sigma_j^2)}}\right]$$

$$\sum_{i,j=0}^{N-1} C(i.j)\log C(i.j)$$

5.3 Image Training:

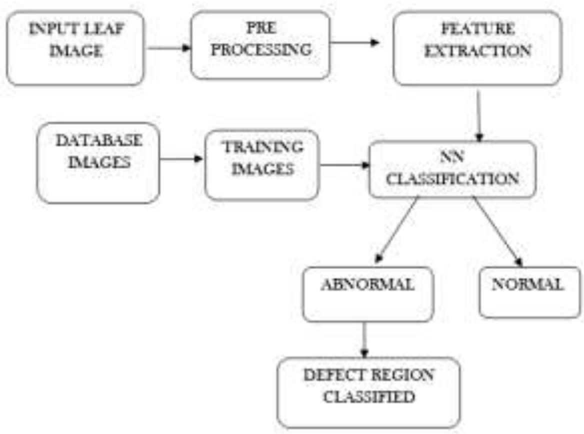
Discrete Wavelet Transform: recommended processing algorithm to transform image data to wavelet coefficient data. A DWT using a 9-tap filter to obtain low-pass wavelet coefficients and a 7-tap filter to obtain high-pass wavelet coefficients. Two different specific 9/7 Discrete Wavelet Transforms are recommended: 9/7 Float DWT for lossy compression and 9/7 Integer DWT for lossless compression



5.4 BPNN Classification

The BACK PROPAGATION NEURAL NETWORK consists of input layer, convolution layer, Rectified Linear Unit (ReLU) layer, pooling layer and fully connected layer. In the convolution layer, the given input image is separated into various small regions. In the final layer (i. e) fully connected layer is used to generate the class score or label score value based on the probability in between 0 to 1.

6. BLOCK DIAGRAM



7. CONCLUSIONS

The proposed system can be used in large scale for immediate detection of plant disease as soon as they occur on the leaves. Using of convolutional neural network will help in automatic addition of data on the database which reduces workload on the system for future use. The proposed system has most accuracy than any other plant disease detection system.

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