International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 4 Issue 03, March-2015

Application of Image Processing Techniques in Plant Disease Recognition

K. Renugambal (PG scholar)
Embedded System Technologies
S.K.P Engineering College
Tiruvannamalai, India

B. Senthilraja (Asst Prof)
Electronics and Communication Engineering
S.K.P Engineering College
Tiruvannamalai, India

Abstract — **The techniques of pattern recognition are widely applied to agricultural science and it has immense perception especially in the plant protection field, which eventually leads to crops management. We propose artificial intelligence technique for automatic detection and classification of sugarcane leaf diseases using image processing technique. Images of the infected sugarcane leaves are captured by digital camera, those images are preprocessed using image histogram equalization, filtering, color transformation and segmentation techniques to detect infected part of the leaves. Then the infected leaf has been used for the classification purpose using Support Vector Machine classifier. This can be achieved by getting the diseased part of a leaf based on the K means clustering method to segment the leaf area and affected area. In conclusion, diseases are classified by calculating the GLCM texture feature of affected area. The methods progressed in this system are both feature analysis and segmentation technique applied on number of diseased sugarcane plants.**

Keywords—Clustering; GLCM feature; k means cluster; pattern recogniion; svm

I. INTRODUCTION

Sugarcane is an important crop in India and many countries. The sugarcane Industry remains one of the main pillars of the Indian economy, though facing many problems. Fungi-caused diseases in sugarcane are the most predominant diseases which appear as spots and stripes on the leaves. These spots prevent the vital process of photosynthesis to take place, hence to a large extent affects the growth of the plant and consequently the yield. In case of severe infection, the leaf becomes totally covered with spots. The plant completely withers down and eventually dies. The spores of the disease are wind-borne. If not treated on time, a whole sugarcane plantation can become infected, resulting in severe loss. Proper disease control measures must be undertaken in sugarcane to minimize losses. Currently, the machine vision and artificial intelligence are being studied to achieve intelligent farming. Early identification of disease symptoms becomes an important aspect of crop disease control. In some cases, disease control actions or remedial measures can be undertaken if the symptoms are identified early. Image processing technology in the agricultural research has made significant development. To recognize and classify sugarcane fungi disease an automated system has been implemented using image processing techniques and pattern recognition techniques.

A. Types Of Disease

There are varieties of disease spots which tend to resemble each other and can easily be confused with one another by inexperienced people. Misunderstanding one spot for another can be quite catastrophic as application of the wrong fungicide will result in loss of money without the plant being treated and allowing more time for the disease to spread further.

1) Red Rot: The disease first appears as red bright lesions on mid rib of leaves and shows itself as drooping and changing of color of upper leaves. Withering of the leaves proceed downwards. Usually third or the fourth leaf from the top is affected and shows drying at the tip. The pith becomes red and later on brown.

2) Leaf Spot: The disease may be characterized itself on leaves as small lesions, which gradually enlarge along mid rib and assure dark red to brown color. In severe infection, the leaves become dry affecting photosynthesis.

3) Sugarcane Mosaic Virus: Mottling of young crown leaves showing a definite pattern of alternating dark and light green colored patches of varying size and run parallel to the midrib of leaf.

4) Yellow Spot: There exist two types of Yellow Spot. The first type of spot is yellow in color. However, in certain varieties of sugarcane with red stalks, the spots appear as red. Despite the color, both types have the same physical characteristics. They are irregular in shape and dimension. They can vary from minute dots to spots attaining 1 cm in diameter.

5) Brown Spot: Brown spot causes reddish-brown to dark-brown spots on sugarcane leaves. The spots are oval in shape, often surrounded by a yellow halo and are equally visible on both sides of the leaf. The long axis of the spot is usually parallel to the midrib. This spot often tends to be confused with the Ring Spot.

II. LITERATURE REVIEW

Many research papers are describing the advancement of image processing for a variety of methodologies.

Libo Liu, Guomin Zhou [1] proposed a system for classifying the healthy and diseased part of rice leaves using BP neural network as classifier. In this study rice brown spot was select as a research object. The images of rice leaves were acquired from the northern part of Ningxia

Hui autonomous region. Here the color features of diseases and healthy region were served as input values to BP neural network. The result shows that this method is also suitable to identify the other diseases. Yan-cheng zang Han-Ping Mao, Bo Hu, Ming-xi Li [2] proposed the fuzzy feature selection approach -fuzzy curves (FC) and surfaces (FS) for cotton leaves disease image feature selection. This research is done in two steps. Firstly to automatically and quickly isolate a small set of significant features from a set of original features according to their significance and to eliminate spurious features they make use of FC. Secondly to isolate the features dependent on the significant features, utilize FS. This approach is useful for practical classification applications which reduce the dimensionality of the feature space. The feature selection technique has faster execution speed and higher classification success rate because it does not suffer from the local minima problems inherent in the nonlinear modeling techniques typically used in forward selection and backward elimination.

P.Revathi, M.Hemalatha[3] proposed a system for Classification of Cotton Leaf Spot Diseases Using Image Processing Edge Detection Techniques. In this paper consists of two phases to identify the affected part of the disease. Initially Edge detection based Image segmentation is done, and finally image analysis and classification of diseases is performed using our proposed Homogeneous Pixel Counting Technique for Cotton Diseases Detection (HPCCDD) Algorithm. Yuan Tian, Chunjiang Zhao,Shenglian Lu,and Xinyu Guo [4] proposed system is composed of three main steps. In first step, segmentation to divide the image into foreground and background. In the second step, support vector machine (SVM) is applied to predict the class of each pixel belonging to the foreground. And finally, further refinement by neighborhood-check to omit all falsely-classified pixels from second step. The proposed method is compared to the existing method and it is concluded that higher accuracy can be achieved with this method. Sanjay B. Patil et al [5] proposed triangle threshold method to segment the lesion region instead of using simple thresholding method. The average accuracy of the experiment is 98.60 %.

Roopesh Kevin Sungkur, Sunilduth Baichoo and Aroun Poligadu [6] implemented a reliable and efficient automated system to recognize fungi-caused disease spots on sugarcane leaves. Pictures of the latter have been taken in a controlled environment using a digital camera. Several descriptors such as Aspect Ratio, Eccentricity, Circularity and Moments Analysis have been analyzed to assess their suitability to recognize the spots. Moments Analysis has proved to be the most useful. A combination of descriptors that gave the best performance has been used to develop the automated system. The system for detection of Leaf diseases[7] with help of the feature extracted by the machine learning approach. They have developed based on computer image processing for grading of plant diseases. The result gives the technique for detection of plant diseases. K means clustering and OTSU thresholding methods are used for segment the image.

III. IMAGE PROCESSING TECHNIQUES

In the present work errands like image acquisition, preprocessing, segmentation, feature extraction, normalization and classification are carried out. The detailed block diagram of proposed methodology is shown in Fig.1

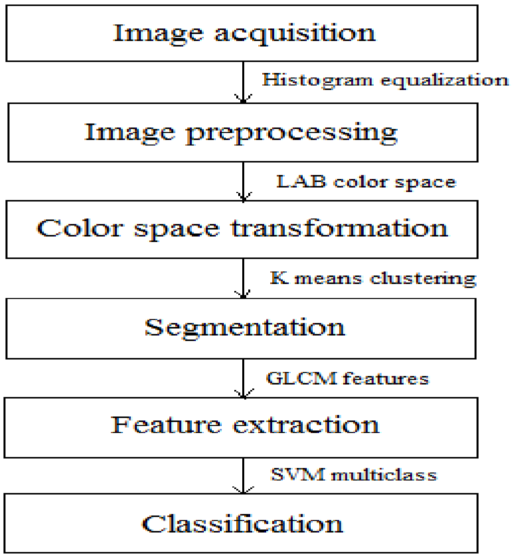

Fig. 1. Block diagram of proposed methodology

A. *Image Acquisition*

Sugarcane diseased leaf images are taken in controlled environment and are stored in the JPEG format. Infected leaf is placed flat on a white background. Light sources are placed at 45 degree on each side of the leaf so as to eliminate any reflection and to get even light everywhere, thus a better view and brightness. The leaf is zoomed on so as to ensure that the picture taken contains only the leaf and white background.

Fig. 2. Diseased sugarcane leaf

B. *Image Preprocessing*

Image preprocessing techniques are basically used to bring out details that are obscured or simply to highlight certain features of interest in an image. These are mainly subjective processes and are designed to manipulate an image in order to take advantage of the psycho visual aspects of the human visual system. Histogram equalization and median filtering techniques were used.

1) Histogram Equalization: It is one of the image enhancement techniques. This method distributes the intensities of the images. Through this distribution, increases contrast of the areas from local contrast to higher contrast. Histogram equalization is used to improve the interpretability, visibility and quality of the image.

C. LAB Color Transformation

This method matches the luminance of the grayscale image to the luminance of the color image. First get the values of three primary colors (Red, Green and Blue) and encodes this linear intensity values using gamma expansion. The *LAB* space consists of a luminosity layer 'L*', chromaticity-layer 'a*' indicating where color falls along the red-green axis, and chromaticity-layer 'b*' indicating where the color falls along the blue-yellow axis. We choose ‘b’ as input for segmentation process.

D. Image Segmentation

Image segmentation is the important step to separate the different regions with special significance in the image, these regions do not intersect each other and each region should meet consistency conditions in specific regions.

The division of an image into its constituent objects or regions is called Segmentation. The level to which the subdivision is carried out depends on the problem being solved. That is, segmentation should stop when the objects of interest or the regions of interest in an application have been isolated. Several techniques have to be applied to achieve a desirable level of segmentation sufficient to carry out recognition.

1). K Means Segmentation: K-means is one of the simplest unsupervised learning algorithms that solve the well known clustering problem.

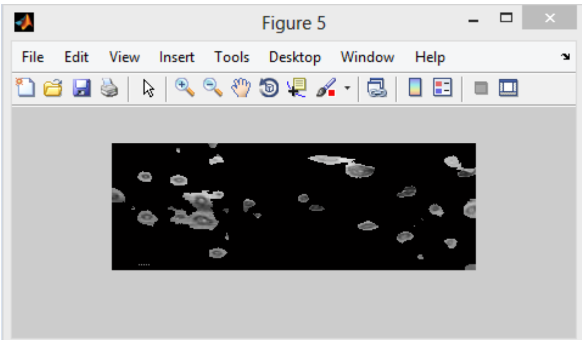

Fig. 3. Segmentation Result after K means clustering

The procedure follows a simple and easy way to classify a given data set through a certain number of clusters (assume k clusters) fixed a priori. The main idea is to define k centroids, one for each cluster. These centroids should be placed in a cunning way because of different location causes different result. So, the better choice is to place them as much as possible far away from each other.

2). Canny Edge Detection: After segmentation process edges are clearly found by the use of canny edge detector. Canny algorithm finds the edges by looking for the local minima of the gradient input image.

3). Feature Extraction: Image texture is a set of matrices calculated in image processing designed to quantify the perceived texture of an image. Grey-Level Co-occurrence Matrix texture measurements have been the workhorse of image texture since they are a button you push in the software that yields a band whose use improves classification.

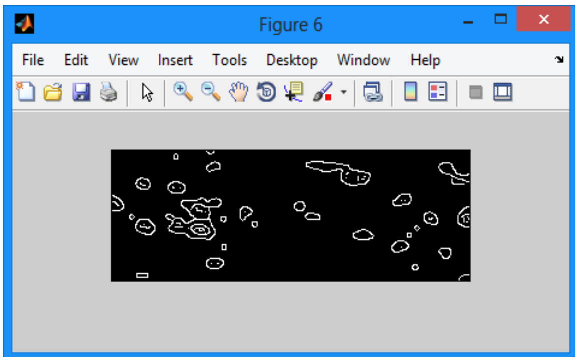

Fig. 4. Edge detection result after Canny filtering

The original works are necessarily condensed and mathematical, making the process difficult to understand for the student or front-line image analyst. This is used for irregular pattern analysis.

In the proposed approach, the method adopted for extracting the feature set is called the Color Co-occurrence Method or CCM method in short. It is a method, in which both the color and texture of an image are taken into account, to arrive at unique features, which represent that image. The image analysis technique selected for this study was the CCM method. The use of color image features in the visible light spectrum provides additional image characteristic features over the traditional gray-scale representation.

The color co-occurrence texture analysis method was developed through the use of Spatial Gray-level Dependence Matrices [SGDM] . The gray level co-occurrence methodology is a statistical way to describe shape by statistically sampling the way certain grey-levels occur in relation to other grey-levels. These matrices measure the probability that a pixel at one particular gray level will occur at a distinct distance and orientation from any pixel given that pixel has a second particular gray level.

Here we compute texture features are Contrast, Correlation, Energy, Homogeneity, Cluster shade and Cluster prominence for the ‘b’ content of the image. From the texture features, the plant diseases are classified into various types. Feature values are shown in Table 1.

TABLE I
SAMPLE VALUES FOR TEXTURE FEATURES

Sugarcane diseased Leaf	Contrast	Correlation	Energy	Homogeneity
Sample 1	2.894	7.826	1.191	5.657
Sample 2	2.877	7.924	1.009	5.543
Sample 3	2.734	7.913	1.130	5.653
Sample 4	2.768	7.625	1.102	5.456
Sample 5	2.701	7.772	1.114	5.667

IV. SVM PATTERN RECOGNITION

Moreover, for the classifier ensemble design of MCS, the design object is basically to make classifiers have “independent” behavior. For example, there are no coincident errors and for each test input there is a classifier that produces the correct answer. To test the “independent behavior” of SVM, we use different –level feature vectors as different training sets, that is, the color, texture and shape feature vectors of each sample are treated as different training sets into three corresponding SVM classifiers.

A. SVM Classifiers

Support vector machines provide a solution to two-class classification problems by mapping the input vectors into a new high-dimensional feature space through some nonlinear mapping, and constructing an optimal separating hyperplane by determining the largest margin to separate positive and negative classes. This concept is illustrated in Figure 4. For the selection of the kernel function as the nonlinear mapping, a degree-2 polynomial kernel is used.

In a SVM a linear training sample is separable by a hyperplane according to the decision function

$$f(x) = \text{sign}(w \cdot x) + b,$$

where w is a weight vector and *b* is a threshold cut-off. To maximise the margin w belongs f and *b* have to be minimized to

$$y_i(w \cdot x_i) + b \geq 1$$

B. Multiple Classes Of Classification

When the problem of classification involves more than two classes, as it is the case in this study, a number of methods can be used to deal with this very common scenario. We used the one against- one method, which constructs $k(k-1)/s$ classifiers where each one is trained on data from two classes.

Multiple Classifiers System is a combination of a number of classifiers and aims to obtain higher classification accuracy. The combination of classifiers is able to complement the errors made by the individual classifiers on different parts of the input space. K different classifiers are trained on the training set and every classifier is able to provide the classification of the input pattern x. Considering an M class classification problem, then in general each classifier will provide M different outputs, like Ok(x). A “decision function” will then take the outputs of the classifiers and eventually also the input pattern x and will produce the final output. The output can be either a scalar value representing the class assigned to the input pattern, or a vector representing an estimation of the a posteriori probability for each class. Like any other classification technique, the probability of correct classification of a MCS strictly depends on the effort devoted to the design of the components. The design of MCSs can be divided into two phases: the design of the classifier ensemble and the design of the decision function.

The following subsections describe as steps to develop the system.

V. RESULTS AND DISCUSSION

A. Types Of SVM Classification Results

Classifying data is a common task in machine learning. Suppose some given data points each belong to one of two classes, and the goal is to decide which class a new data point will be in.

1) Linear Classification: In the support vector machines, a data point is viewed as a p-dimensional vector and we want to know whether we can separate such points with a (p − 1)-dimensional hyperplane. This is called a linear classifier.

There are many hyperplanes that might classify the data. One reasonable choice as the best hyperplane is the one that represents the largest separation, or margin, between the two classes. So we choose the hyperplane so that the distance from it to the nearest data point on each side is maximized. If such a hyperplane exists, it is known as the maximum-margin hyperplane and the linear classifier it defines is known as a maximum margin classifier.

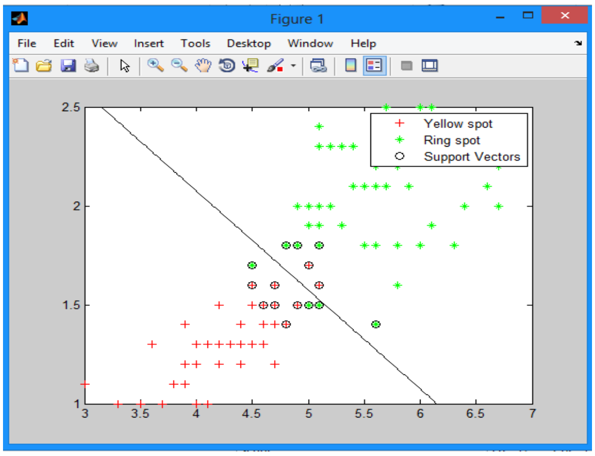

Fig. 5. Linear classification result

2) Non Linear Classification: The original optimal hyperplane algorithm suggested a way to create nonlinear classifiers by applying to maximum-margin hyperplanes. The resulting algorithm is formally similar, except that every dot product is replaced by a nonlinear kernel function. This allows the algorithm to fit the maximum-margin hyperplane in a transformed feature space.

The transformation may be nonlinear and the transformed space high dimensional; thus though the classifier is a hyperplane in the high-dimensional feature space, it may be nonlinear in the original input space. To evaluate classification performance, our experimental study focuses on the comparison between ANN and SVMs that is trained by the single-step learning approach.

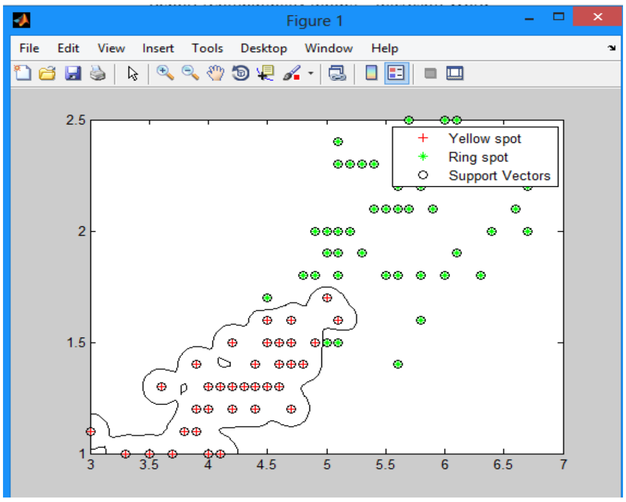

Fig. 6. Non Linear classification result

The training and test data sets for both approaches include 100 images of five diseases of sugarcane leaves. As for the mid-categories, we manually assigned for the color and shape feature sets of original datasets.

TABLE II
ACCURACY FOR CLASSIFIERS

Classifiers	Accuracy Obtained
ANN	85%
Linear SVM	91%
Non Linear SVM	94%

VI. CONCLUSION

The identification of sugarcane plant diseases by means of a machine vision system may support farmers during their daily struggle against disease outbreaks. Here we used digital images of sugarcane plants that showed symptoms of a particular disease. These diseased regions were identified and segmented with the help of K means algorithm. GLCM features were extracted from each segmented region and used as inputs to a classifier. Because not all features were supposed to give the same amount of information about the target, we used cross-validation to identify those which comprised the best classification model. Firstly, the measurements of texture can be used as a useful discriminator for these types of images. Secondly, SVM machine learning systems can be used to identify the visual symptoms of plant diseases and this may have a particular application for crop produces in cultivation field. An extension of this work will focus on developing fuzzy optimization algorithms in order to increase the recognition rate of the classification process.

VII. REFERENCES

[1] Libo Liu,Guomin Zhou,"Extraction of the Rice Leaf Disease Image Based on BP Neural Network",2009 IEEE.

[2] Yan Cheng Zhang, Han Ping Mao, Bo Hu, Ming Xili ,2007."Features selection of Cotton disease leaves image based on fuzzy feature selection techniques".IEEE Proceedings, Beijing, China, :124-129.

[3] P. Revathi, M. Hemalatha , "Classification of Cotton Leaf Spot Disease Detection Using Image Edge detection" , IEEE-20180, ICCCNT'12 ,26t _28t July 2012, Coimbatore, India

[4] Yuan Tian, Chunjiang Zhao,Shenglian Lu,and Xinyu Guo,"SVM-based Multiple Classifier System for Recognition of Wheat Leaf Diseases", (CDC'2010) November 20-22, 2010, Yichang, China.

[5] Sanjay B. Patil, Dr. Shrikant K. Bodhe "Leaf Disease Severity Measurement Using Image Processing" IJET, Vol.3 (5), 2011.

[6] Roopesh Kevin Sungkur, Sunilduth Baichoo and Aroun Poligadu "An Automated System to Recognise Fungi-caused Diseases on Sugarcane Leaves" Science and Technology Conference 3-4 October 2013.

[7] Mrunalini R. Badnakhe and Prashant R. Deshmukh "Infected Leaf Analysis and Comparison by Otsu Threshold and k-Means Clustering" IJARCSSE, Volume 2, Issue 3, March 2012.

[8] Prof. Sanjay B. Dhaygude, 2Mr.Nitin P.Kumbhar "Agricultural plant Leaf Disease Detection Using Image Processing" IJAREEIE, Vol. 2, Issue 1, January 2013.

[9] A. Camargoa, J.S. Smithb "Image pattern classification for the identification of disease causing agents in plants" Computers and Electronics in Agriculture 66 (2009) 121–125

[10] Santanu Phadik ar and Jaya Sil "Rice Disease Identification using Pattern Recognition Techniques" ICCIT , 25-27 December, 2008, IEEE

[11] Tushar H Jaware, Ravindra D Badgujar and Prashant G Patil," Crop disease detection using image segmentation", Proceedings of "Conference on Advances in Communication and Computing (NCACC'12)", April 21, 2012.

[12] Sannakki S.S., Rajpurohit V.S., Nargund V.B., Arun Kumar R.and Yallur P.S.," A Hybrid Intelligent System for Automated Pomgranate Disease detection and Grading", International Journal of Machine Intelligence ISSN: 0975–2927, Volume 3, Issue 2, 2011, pp-36-44

[13] Zulkifli Bin Husin, Abdul Hallis Bin Abdul Aziz, Ali Yeon Bin Md Shakaff, Rohani Binti S Mohamed Farook "Plant Chili Disease Detection using the RGB Color Model " RNIS, Volume13,May 2013

[14] Pranjali Vinayak Keskar, Shubhangi Nimba Masare, Manjusha Suresh Kadam and Prof. Mrs. Seema U.Deoghare," Leaf Disease Detection and Diagnosis", International Journal of Emerging Trends in Electrical and Electronics (IJETEE) Vol. 2, Issue. 2, April-2013

[15] Ajay A. Gurjar, Viraj A. Gulhane," Disease Detection On Cotton Leaves by Eigenfeature Regularization and Extraction Technique", nternational Journal of Electronics, Communication & Soft Computing Science and Engineering(IJECSCSE)Volume 1, Issue 1.