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Assessment of Chlorophyll and Nitrogen Contents of Leaves Using Image Processing Technique

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Abstract – Leaf color has been commonly used as an index for crop stress status diagnosis. Leaf colour is usually used as a guide for appraisal of nutrient status and plant health and so to determine nitrogen and chlorophyll contents also. Chlorophyll and Nitrogen are dependent on each other. Assessment of one will detect content of other. Many methods are developed to find these two. These approaches are of two categories- Destructive and Non destructive. However, Image processing technique is proving to be proficient among all these; which come under non destructive method. We have developed a low-cost and non-destructive method that is easy to use to assess the health status of plants, based on the estimation of chlorophyll and nitrogen content of leaves using a portable digital camera..We also proposing a new algorithm with good efficiency.

Key Words: Digital image processing; k -means clustering; GLCM; Nitrogen; Chlorophyll; Support vector machine.

1. INTRODUCTION

The main tenure of India is agriculture, Indian soil is comprise of many minerals and organic elements, and inspection has resolved that soil and SVM classifier. All plants require adequate supplies of macronutrients for healthy growth, and nitrogen is a nutrient that is heavily available in Indian agricultural soil and which should not be in restricted supply. It is manual and time devastating. Plants, like all other living things, need food for their growth and development. Plants demand 16 fundamental elements. Carbon, hydrogen, and oxygen are derived from the atmosphere and soil water. The remaining 13 fundamental elements (nitrogen, iron, phosphorus, calcium, magnesium, sulphur, zinc, manganese, potassium, copper, boron, molybdenum, and chlorine) are supplied either from soil minerals and soil organic matter or by organic or inorganic fertilizers. Nitrogen (N) is a major element for plant growth and is a radical part of chlorophyll (Ch), which is primary absorber of light energy needed for photosynthesis. Ch and N affects the green color of plants and ultimately determines their biomass yield and quality. Plants adequately supplied with N are green and healthy, while plants inadequately supplied with N are pale green or yellow in color and remain small and retarded. Hence, leaf color changes have led researchers to exploit this property by using image processing analyses to detect Ch and N status in plants if there is deficiency in the content then proper measures can be taken by farmers to improve the nutrients in crops. Thus it will be helpful in guiding the need of type and the amount of the pesticide which will be very helpful in agriculture industry. Digital image processing is superior to manual process hence we will be able to save time and human error. Computer algorithms are used for texture analysis. Digital image processing is superior to manual process hence we will be able to save time and human error. The quality and quantity of crop yields are related to its nutritional availability. Over-fertilization cause environmental issues while under-fertilization cause yield reduction and poor yield quality. Various image processing tools and approaches were widely used in order to identify and detect various contents in plant leaves. The aim of this paper is to help farmers in predicting the exact value of nitrogen and chlorophyll content of leaves using support vector machine classifier so as to increase the efficiency and prediction accuracy in comparison with the other approaches.

2. RELATED WORK

Mr. Dalgade Viren Suryakant [1] had estimated the nitrogen content by evaluating the nitrogen deficiency in pomegranate leaves. They collect different Nitrogen deficient leaves and estimated the chlorophyll content of the collected leaves. They captured the images of collected leaves under the closed environment. These leaves are sent to the chemical analysis for the nitrogen estimation. The captured images are compared with database and then calculated the nitrogen deficiency of leaf. For irrigated crops, plant analysis can be used as an option in Extracting the statistical features of images and creating the database.

The purpose of this study [2] is to estimate N of paddy build on leaf reflectance using Artificial Neural Network (ANN). In this study, 45 leaf samples were randomly selected under various environmental conditions. Leaf reflectance was measured by handheld spectrogram diameter while actual leaf N content was determined by Kjeldahl method. Spectral reflectance data in visible band (400–700 nm wavelength region) and actual N content were used as input and target data in ANN model building. K-fold cross validation (k=3) method was applied to select the best model and measure

the overall accomplishment of model. Results indicated that ANN model with 17 neurons of hidden layer in relatively could estimate N properly. It was shown by the lowest root mean square error (RMSE) of 0.23 and the highest exactitude of 93%. This study promises to help farmers predicting N content of paddy for optimal N fertilizer application.

In this research[3] V. K. Tewari basically use to estimate the status of the plant nitrogen content / chlorophyll content in the field condition, so as to avoid the intricacies involved in other method such as chemical analysis. An experimental setup was developed to fulfill both the requirements in field condition; this was able to produce the constant illumination (artificial) and a uniform background for the image. These features were correlated with SPAD reading, which represent nitrogen / chlorophyll content of plant. Regression model were developed between various image feature and the plant nitrogen content. When this model was tested, the minimum accuracy was found to be 65% with an average accuracy of 75%, actual and predicted values of nitrogen percent were linearly correlated with *R*2 value (0.948).These results show that the plant nitrogen content can be successfully estimated using its color image feature.

John William ORILLO's [4] proposed a system that is used to assess the nitrogen level of rice plant using neural network The colour characteristics of the leaves were properly extracted and computed before it was fed into the neural network. The system was able to overcome the bias of color perception, and provided an accuracy of 93.33%.

Table -1:

Literature review		
Sr no.	Name of Authors	Remark
1	Mr. Dalgade Viren Suryakant	We have observed there Artificial Neural Network Technique is used that is very useful, and detect the various plant diseases with at most 94-95% accuracy.
2	Whine Ayu Lestari,Yeni Herdiyeni, Lilik Budi Prasetyo	Results indicated that ANN model with 17 neurons of hidden layer in relatively could estimate N properly. It was shown by the lowest root mean square error (RMSE) of 0.23 and the highest prediction accuracy of 93%.
3	V. K. Tewari*, Ashok Kumar Arudra, Satya Prakash Kumar,Vishal Pandey, Narendra Singh Chandel	Regression models were developed and evaluated between various image feature and the plant nitrogen content and observed that, the minimum accuracy was found to be 65% with an average accuracy of 75%
4	John William Orillo, Gideon Joseph Emperador#2, Mark Geocel Gasgonia, Marifel Parpan, Jessica Yang	The system was observed to provide an accuracy of 93.33%.

2. PREPOSED METHODOLOGY

Collect the sample of leaves. Capture the image of collected samples under the uniform illumination with a light background. To capture images a Minimum of 16mega pixel camera is required. .Nitrogen and chlorophyll content of leaves collected is calculated from laboratory using manual process which becomes the reference for development of proposed system here we are using **A Global Data Set of Leaf Photosynthetic Rates, Leaf N and P, and Specific Leaf Area** from **NASA Earthdata Network.**

Image Acquisition:-

Image Acquisition is one of the important phases in image classification system. The image acquisition is done using a digital camera and it is loaded and saved using JPEG format in the current directory. It supports file formats such as GIF (TIFF), JPG (JPEG), BMP (bitmap).Image should be of 256x256 dimensions, while image acquisition the image will be resized and saved in 300x400 dimensions.

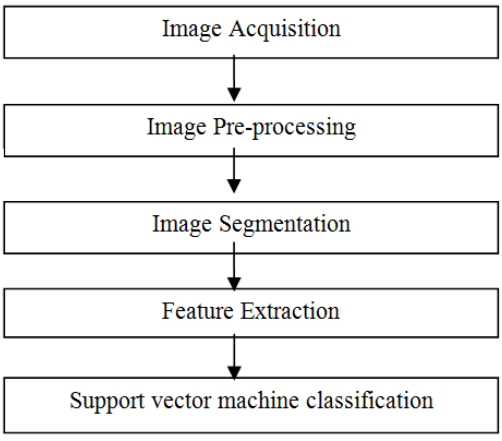


Image Pre-processing:-

To improve the database of images that suppress undesired distortion Image pre-processing is to be done. Enhance image feature is important for further processing and analysis task .It includes color space conversion, image enhancement for contrast improvement, image resizing, filtering to remove noise etc.

Steps Used here are:

- Color space transformation: That is RGB image is transferred in to gray scale image using formulae
- Where *R, G, B correspond to the colour of the pixel, respectively.*
- *Gray = 0.2989 ∗ R + 0.5870 ∗ G + 0.1140 ∗ B (7)*
- ***Image Resizing*:** In this work, all images must be with the same size and equal dimension. So, the gray image should be resized to equal dimensions.
- ***Image enhancement*:** The Image enhancement process involves noise reduction and contrast adjustment. The value colour plane had its intensity adjusted so that the darker parts of the image goes Darker to aid the image segmentation process .

Image Segmentation:-

Segmentation means partitioning of images into various part or region and extracting meaningful region known as region of interest (ROI).The level to which subdivision is carried depends on the problem being solved .Segmentation can be stopped when the region of interest in an application have been separated. Segmentation exactitude determines success or failure of computerized analysis operation. So algorithm picked for segmentation should perform best for given requirement. The segmentation can be done using various methods like Otsu' method, k-means clustering, converting RGB image into HIS model etc.

K-means clustering

Clustering is a method to divide a set of data into a specific number of groups. It's one of the popular method is *k*-means clustering. In *k*-means clustering, it divides a collection of data into a *k* number group of data11, 12. The algorithm is also significantly sensitive to the initial randomly selected cluster centres.It classifies given set of data into *k* number of disjoint cluster. *K*-means algorithm consists of two separate phases.

In the first phase it estimates the *k* centroid and in the second phase it takes each point to the cluster which has closest centroid from the data point. There are different methods to define the distance of the nearest centroid and one of the most used methods is Euclidean distance. Once the grouping is done it recalculate the new centroid of each cluster and based on that centroid, a new Euclidean distance is evaluated between each center and each data point and assigns the points in the cluster which have minimum Euclidean distance. Each cluster in the partition is defined by its member objects and by its centroid. The centroid for each cluster is the point to which the sum of distances from all the objects in that cluster is minimized.

Feature Extraction using GLCM:-

Feature Extraction is a method of capturing visual content of images for indexing & retrieval. Primitive or low level image features can be either general features, such as extraction of color, texture and shape or domain specific features. This paper presents an application of gray level co-occurrence matrix (GLCM) to extract second order statistical texture features for motion estimation of images. The Four features namely, Angular Second Moment, Correlation, Inverse Difference Moment, and Entropy are computed.

1. **GLCM generation.** Before applying GLCM method to input images, we must be sure that we can get texture feature for leaf part only. So we convert all pixels outside the leaf using mask to (NaN) "Not a Number", to be ignored during GLCM calculation. After that, GLCM has been calculated using the following angles (0◦, 45◦, 90◦, 135◦). So that, we have got 4 GLCM.

2. **Texture feature calculation.** The GCLM that generated in the last step were then used to evaluate the texture features. A number of texture features may be extracted from the GLCM . In this work 7 texture features, as shown in equation (1) to equation (7), have been extracted as follow: Calculate GLCM using the following angles (0◦ , 45◦ , 90◦, 135◦), so we got 4 GLCM.

– Contrast:

$$\text{CONTRAST} = \sum_{i,j} |i-j|^2 p(i,j) \quad (1)$$

– Entropy:

$$\text{ENTROPY} = -\sum_{i=0}^{G-1} \times \sum_{j=0}^{G-1} P(i,j) \times \log\left(P(i,j)\right) \quad (2)$$

– Mean:

$$x = \sum x/N \quad (3)$$

Where: x =(Sometimes call the x-bar) is the symbol for the mean.

∑=is the symbol for summation.

x =is the symbol for the scores.

N =is the symbol for the number of score.

– Correlation:

$$\text{CORRELATION} = \sum_{i,j} \frac{(i-\mu i)(j-\mu j)p(i,j)}{\sigma i \sigma j} \quad (4)$$

– Variance:

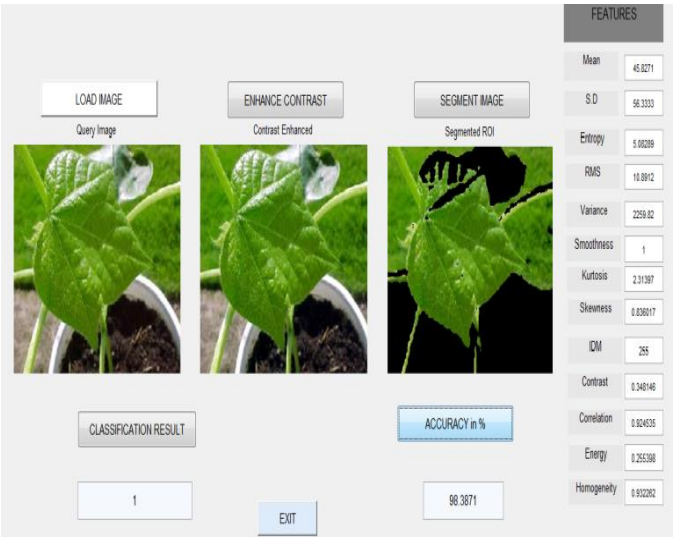
$$= \frac{\sum_{i=1}^{n}(X_1^n - X_{\pi})^2}{n-1} \quad (5)$$

– Inverse Difference Moment:

$$= \frac{\sum_{i=0}^{Ng-1}\sum_{j=0}^{Ng-1} Pij}{1+(i-j)^2} \quad (6)$$

– Skewness:

$$= \frac{E(x-\mu)^3}{\sigma^3} \quad (7)$$



3. CONCLUSION

This research was basically undertaken to estimate the status of the plant nitrogen content / chlorophyll content in the leaf, so as to avoid the complexity involved in other method such as chemical analysis. Digital image processing was selected as the tool to estimate plant nitrogen content in leaf. We aimed to evaluate the applicability of a fast and non-invasive method for the estimation of total chlorophyll and nitrogen content of plants using a smart phone camera. The review of literature says about how to estimate nitrogen content in plant leaf. The estimation of nitrogen content in leaf is done based on colour and texture features .The review outlines several methods for estimation of nitrogen content in the leaf. The estimation methods are costlier and time consuming. The image processing methods reviewed is this paper gives a cost effective and speedier approach for estimating nitrogen content in leaves.

Further work can be carried out as the extension of the outlined work in the paper. Leaf image can be capture under Different lighting condition and their effect can be analysed and the accuracy of estimation can also be increased.

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