ESTIMATION OF NITROGEN CONTENT IN LEAVES USING IMAGE PROCESSING

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Abstract- Agriculture is the science or practice of farming, including cultivation of the soil for the growing of crops and the rearing of animals to provide food, wool, and other products. Nitrogen is one of the abundant mineral which plays important role in yield of crops. The paper aims to introduce software "Nitrate app". The software has revolutionized the method to find nitrogen content in leaves. Approach is to turn the manual process to a software application using image processing. Image of the Maize leaf is captured and preprocessed to remove the noise of source image. The color and texture characters of maize leave are extracted. Color characteristics analyzed using the RGB and the HSV model. Texture features are analyzed using entropy, energy, contrast, homogeneity. A relationship between extracted features and nitrogen content is developed. The document goes further to discuss the process used by the authors to develop their engineering capstone project i.e. "Nitrate app".

Keywords- Nitrogen, Image processing, Maize leaves, Texture, Feature, Color.

I. INTRODUCTION

The main occupation of India is agriculture, Indian soil is composed of many minerals and organic elements, and survey has concluded that soil is composed as 1% of organic elements and rest 99% of mineral content. Nitrogen is one of the abundant mineral which plays an important role in yield of crops. If there is deficiency in the content then proper measures can be taken by farmers to improve the nutrients in crops. Present way to find nitrogen content is kjeldhahl method. Nitrate test strip and nitrate meter are other existing systems. This consumes time, man power and costlier. To overcome these we are proposing a system that will find out the nitrogen content in the leaves using image processing technique. Digital image processing is superior to manual process since we will be able to save time and human error.

Computer algorithms are used for texture analysis. IT sectors help the agriculture in many different aspects such as India expands kissan call center to help farmers. Online websites are available and online bidding of crops. Software which can predict the soil fertility of a land after harvesting a particular crop etc.. Proposed system is other automation using software.

"Estimation of nitrogen content in maize leaves" the aim of the proposed system is to overcome the problems of traditional methods and to help agriculture system to re-organize the total system towards a low-input, higher-efficiency, higher profit in estimating the content of nitrogen in maize leaves using image processing technique. All plants require sufficient 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 limited supply. It is manual and time consuming. Proposed system overcomes these problems and gives an efficient way to estimate the nitrogen content.

II. LITERATURE SURVEY

Traditionally, nitrogen status in maize crops is measured by 4 traditional methods, namely chemical test, normalized difference vegetation index, SPAD meter and leaf color chart. Each method has its advantages and disadvantages.

A. Chemical Test method

Kjeldahl method is a method for quantitative determination of nitrogen in chemical substances developed by Johan Kjeldahl, a Danish chemist, in 1883. This method is the most accurate and also the most time-consuming method. It may take a week for 72 samples so this method is not suitable for rapid determination nitrogen concentration in the large area.

B. NDVI(Normalized Difference Vegetation Index)

It is a numerical indicator that uses the visible and near infrared bands of the electromagnetic spectrum to observe whether the target contains live green vegetation or not [8]. The light that plants absorb or not absorb can indirectly measure how much nitrogen the plants have. NDVI can be obtained from satellite image which may have high cost and not suitable for determining nitrogen in small area.

C. SPAD Meter

It is chlorophyll measurement device. It is used by clipping the meter head on the leaf, the meter measure transmission of 650 nm red light which

chlorophyll absorb it and transmission of 940 nm infrared light which chlorophyll does not absorb.

The meter gives the relative value that has no unit but since the nitrogen quantity is vary with the quantity of chlorophyll, there are many researches study on converting SPAD value to nitrogen quantity in plant so the meter can be used to measure nitrogen quantity in plant too [8]. This method suitable for medium area because of measuring nitrogen in 1 leaf, the sample leaf must be measured by SPAD meter at least 5 times and then find the average value. For a large area which contains many samples, it is very time-consuming.

D. Leaf color chart

It is a color chart consists of many shade of leaf color from light green to dark green. It is used by cutting the sample leaf out and compares leaf color with the color in the chart. The chart will give a range of nitrogen quantity possible in that leaf. Different species crop uses different chart [9]. This is the easiest but also the least accurate method and it is suitable for medium area. All four methods are not suitable for measuring nitrogen concentration in maize crop. The chemical test method takes too much time, NDVI method costs too much money from satellite image, leaf color chart are not accurate enough and SPAD meter is hard to use and take too much time when using with maize crop. The suitable method should be able to measure quickly and accurate enough so new method should be developed.

E. Paper Details

Paper titled "Color Analysis of Leaf Images of Deficiencies and Excess Nitrogen Content in Soybean Leaves" by Lili Ma and team From Agricultural Engineering Research Center Northeast Agriculture University Harbin, P.R.China Proposed that applying image processing technique, this paper studied the leaf images of the six stages of soybean growth, which nitrogen fertilizer applied were 0%, 50%, 100% and 150%. Using image preprocessing, the noise of source image was removed and the areas of interest were enhanced, leaves and background were separated using minimum error threshold method. The color characters of soybean leaves were analyzed using the RGB and the HSI model. "Study of Monitoring Leaf Nutrition Based on Image Processing and Spectral Analysis" by Xu Yuanfang and team from Key Laboratory of Modern Precision Agriculture system Integration Research, Ministry of Education, China Agricultural University, Beijing Mentioned that Images of the fresh leaves are grabbed and the nutrition content of leaf is acquired in the laboratory. And then, the relationship between the color features and the nutrition content is studied to find a quick and reliable method by which the maize nutrition can be estimated in a non-destructive way. The color components are extracted from the pre-processed images; include R, G, B components of the RGB model and H, I components of the HSI model. In above both the papers only color features are considered. Proposed system both color and texture features are extracted to increase efficiency.

III. PROPOSED SYSTEM

Fig 1 shows the architecture of proposed system. The detailed explanation of each block is given below.

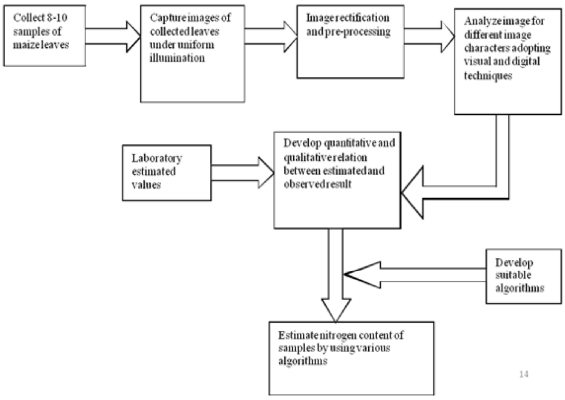

Fig 1. Architecture diagram

A. Sample collection

Collect the sample of maize 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 content of leaves collected is calculated from laboratory using manual process which becomes the reference for development of proposed system.

B. Image preprocessing

Outside interference will cause a variety of noise in the process of image acquisition, which will significantly affect the quality of The image [4]. The Larger skeleton of the leaves will also bring adverse effects in the process of color parameters the extraction of color features. So it is needed to preprocess the image, such as removing noise and enhancing image.

The noises of collected image often show as the mutation of the isolated pixel in the image that is the small particles in the image, which is called as grain noise. Grain noise show High frequency characteristics and it has great gray difference. Also the spaces are not interrelated [5]. The commonly used methods of smoothing were the median filter, Neighborhood mean, spatial low pass filter and frequency low pass filter.

In this study, we use the method of the median filter.

There are significant gray differences between enhanced image and background.

C. Gray level cooccurence matrix

A GLCM is a square matrix which consists of the same number of rows and columns as the number of gray levels in an image. Each matrix element P(i,j|Δx,Δy) represents the relative frequency with which two pixels, separated by a pixel distance (Δx,Δy) occur within a given neighborhood, one with intensity i and the other with intensity j.GLCM's are very sensitive to the size of the texture samples. So the number of gray levels is reduced. For the reliability of the statistical estimate, the matrix must contain a reasonably large occupancy level. To achieve this either the number of gray level values is reduced or a larger window is used. A compromise of the two approaches is generally used. Properties of GLCM are used for texture feature extraction.

D. Texture Analysis

Texture is a feature used to partition images into regions of interest, and to classify those regions. It provides information in the spatial arrangement of colors or intensities in an image. It is characterized by the spatial distribution of intensity levels in a neighborhood. It is a repeating pattern of local variations of image intensity. Texture consists of texture primitives or texture elements called texels. Such features are found in the tone and structure of a texture. Tone is based on pixel intensity properties in a Texel while the structure represents the spatial relationship between texels. If texels are small and tonal differences between the texels are large, a fine texture results. If texels are large and consist of several pixels, the resulting texture is coarse [6].

E. Estimation of nitrogen content

From the texture and color analysis the various values of extracted features are stored in database. Feature values extracted for the test image is compared with the database values to build a correlation. Nitrogen content is obtained for the test leaves.

IV. TEXTURE FEATURES

Texture features like Intensity, correlation, homogeneity, energy, entropy and contrast are extracted along with color features.

A. Contrast

Contrast is the difference in luminance and/or color that makes an object (or its representation in an image or display) distinguishable.

Contrast is calculated using the formula below:

$$\sum_{i,j} |i-j|^2 p(i,j)$$

B. Entropy

E = entropy(I) returns E, a scalar value representing the entropy of gray scale image I. Entropy is a statistical measure of randomness that can be used to characterize the texture of the input image.

Entropy is defined as sum (p.*log2 (p))

C. Correlation

Correlation is a measure of gray level linear dependence between the pixels at the specified positions relative to each other.

Correlation is calculated using the formula below:

$$\sum_{i,j} \frac{(i-\mu i)(j-\mu j)p(i,j)}{\sigma i \sigma j}$$

D. Homogeneity

Homogeneity Returns a value that measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal. Range = [0 1] Homogeneity is 1 for a diagonal GLCM.

Homogeneity is calculated using the formula below:

$$\sum_{i,j} \frac{p(i,j)}{1+|i-j|}$$

V. COLOR FEATURES

Color features such as RGB and HSV are extracted.

A. RGB

RGB color system can change color value through changing the base color and color equation, which can be used to denote the color that has mixed.

B. HSV

HSV color system is directly described by brightness (or lightness), tonality and saturation, which are suitable for the human habit of the color description. It is easy for human visual system to distinguish different tonalities, but it is difficult to distinguish different color through brightness and saturation. In the system, H is defined as tonality; I and S are defined as light intensity and saturation respectively. For the above characteristics correlation model is developed to analyse the dependency of nitrogen over the characteristics.

VI. PROCEDURE

Collect the samples of leaves and capture the image under uniform illumination. Nitrogen content of leaves collected is calculated from manual process in the laboratory which becomes the reference for the development of proposed system. Image is preprocessed and texture features are extracted. Next the image is converted to gray scale for GLCM calculation. The image is resized to form a square matrix. GLCM is calculated. Next all the texture feature values are calculated using the formulae mentioned above. All these texture feature values are loaded into a matrix. The same procedure is followed on a number of leaves and all the texture and color feature values are loaded into a single matrix. Next test image is taken and its texture feature values are

extracted using a similar procedure. MATLAB software is used for the implementation of algorithm. The reason for the choice of software is it provides a good number of tools for image processing which can be easy to use. A correlation is developed from the values extracted and the laboratory values to determine the nitrogen content in maize leaves. Proposed system allows user to load image of size 512 X 512. User can view nitrogen content along with the report generated. Report contains details about the deficiency or excess content of nitrogen in leaf. This helps formers to plan for fertilization.

VII. ADVANTAGES OF PROPOSED SYSTEM

Process consumes less time than existing system and is Accurate giving instant results for users. Economical and consumes less number of sample leaves for testing.

VIII. RESULT AND DISCUSSION

First the software opens a dialog box for selecting the test image from anywhere in the computer. When the selection is done the image is resized and preprocessed. For train images texture and color features are extracted and their value is stored in the database. Test image texture and color features are extracted and are compared with database. Based on the correlation the nitrogen value is extracted and report is generated. Table 1 gives the detail of maize leaves images along with the nitrogen content obtained from laboratory using Kjeldahl method.

Table 1. Image and respective nitrogen value

Leaves image	Nitrogen content (in %)
	1.176
	0.47
	1.792
	1.722
	1.4
	1.036
	1.274
	0.602
	1.162

CONCLUSION

Proposed system is an automated technique to estimate the nitrogen content in maize leaves. System finds the nitrogen content along with report generation that gives information about whether the input leaf is deficient or healthy. It gives proper suggestion based on the result and report generated. Use of image processing makes it accurate and error free.

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REFERENCES

[1] LUO Junhui and FENG Ping the application of MATLAB7.0 in image Processing.2005 pp.140-160.

[2] Wang Xiaomin and team “Detection of maize leaf nutrition based on image processing technology”, M.S Dissertation, China Agricultural University, Beijing, 2008.

[3] Y. C. Tian, X. Yao, J. Yang, W. X. Cao, D. B. Hannaway, and Y. Zhu, “Assessing newly developed and published vegetation indices for estimating rice leaf nitrogen concentration with ground- and space-based hyperspectral reflectance” Field Crops Research, vol. 120, no. 2, pp. 299-310, 2011.

[4] Rafael C.Gonzalez and Richard E.Woods, “Digital Image Proccssing,” 2rd ed, 1997:pp.224~257.s

[5] ASM International, “Practical Guide to Image Analysis.” ASM International ,2000.

[6] Kittler J Illingworth J Minimum error thresholding[J]. Pattern Recognition, 1986, 19(1):pp.41-47

[7] X. Xiong, "the relationship among ndvi, nitrogen And irrigation on Bermuda grass," Faculty of the Graduate College of the Oklahoma State University, Oklahoma, 2001.

[8] A. W. b. S. A. Suchanya Jaroenseng a, "Results of Studies the Possible Correlations between SPAD Value and Total," J. ISSAAS, vol. 16, no. 1, pp. 123-161, 2010.

[9] V. K. S. M. K. S. R. K. S. S. K. Avijit Sen, "Leaf Colour Chart vis-a-vis Nitrogen Management," American Journal of Plant Sciences in Different Rice Genotypes , vol. 2, pp. 223-236, 2011.

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