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DETERMINATION OF PRIMARY NUTRIENTS DEFICIENCY IN PLANT USING IMAGE PROCESSING

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Abstract: - Every living organism in this world requires the sufficient amount of the variety of proteins and nutrients for their normal growth. Similarly the plants also require sixteen different types of nutrients for the normal growth and to produce quality yield. Deficiency of any of the nutrient in the plant affects the normal growth and in turn results in to production loss and poor quality of yield. In early days there are several laboratory methods developed to perform the analysis of plant leaf in order to detect the nutrients deficiencies in plant by using chemical processes. This overall process takes around seven days for the analysis and its results. The lab results also contain the remedy to overcome the deficiency. But the chemical processing methods are time consuming and costly. Mostly diseases are seen on the leaves or stems of the plant. According to the visual observation of the pattern appearing on the leaf of plant, the observer used to decide which pesticide/ fertilizer to be use but no idea how much. Hence some time wastage of money and overdose of pesticide/ fertilizer may disturb the life cycle of plant as well as surrounding. This work gives the fast and accurate solution to analyze the different patterns caused due to different primary nutrient deficiencies in the plant of cotton by using image processing techniques. It is possible to detect the percentage deficiency of nutrients by simply taking the image of crop and processing it to get the analytical results so that one can apply the appropriate amount of pesticide/ fertilizer at right time to the crop

Keywords: Image processing, Cotton, Nutrients, Deficiency

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INTRODUCTION

As India is an agricultural country and 70% of the population depends on agriculture. Observers have wide range of diversity to select particular fruit and vegetable crop for optimum throughput. However the cultivation of these crops for optimum yield and quality product is highly technical. It can be further increased by the aid of technological support. Maharashtra is the important cotton growing state in India with 31.33 lacks hectores area and production of approximate 62 lack bales. The second largest producer of cotton in the world, about 3 million observers is engaged in cotton cultivation in the state mostly in backward region of Marathwada and Vidarbha.^[1]

The cotton leaf mainly suffers from the diseases like foliar leaf spot of cotton, fungus, viral diseases. About 80% to 90% of diseases reflect the symptoms on the leaves of cotton plant. Hence we are focusing on the pattern changes in the leaf of cotton. These diseases mainly occurs due to the deficiency of nutrients^[1].The image processing now a day's become the key technique for the diagnosis of various features of the crop, providing new approach to explore the field of agriculture. The image processing can be used in the agricultural applications for the following purposes.^[2]

1. To detect diseased leaf, stem, fruit.
2. To determine affected area by disease.
3. To find shape of affected area.
4. To determine the size and shape of fruits.

Leaf area is one of the most important features that describe the deficiency of leaf. In case of nitrogen deficiency, the cotton leaf size gets reduce than that of normal leaf hence by calculating the area of deficient leaf and comparing it with that of healthy leaf, it is possible to conclude that the leaf is nitrogen deficient. The Nitrogen deficiency shows reduction in area with pale yellowish color on leaf. Similarly Phosphorus (P) deficiency shows the symptom like leaves with dark green color with reduced leaf size and and Potassium (K) deficiency results in leaf with reddish brown.^[3]

2. METERIALS & METHODS

The work is implemented by using the 14MP SONY CYBERSHOT Digital camera and the MATLAB software.

2.1. System Layout.

Different processing techniques and different approaches are used to perform analysis on the plant. This work proposes another approach for the detection of nutrient deficiency in cotton crop by processing the captured image through MATLAB software. In this method the image captured by using 14 MP digital camera is preprocessed for the noise removal. Since all the nutrients deficiencies result in different color patterns, these variations in the patterns are classified with respect to healthy leaf in the color space. The various features of RGB image are extracted using CIE La*b* color space model to determine the deficiency. The feature extraction may involve Spectral features such as special color or tone, spectral parameters, Geometric features such as area of leaf and Textural features such as pattern, spatial frequency etc. Generalized project flow diagram is as shown in figure 2.1. Depending on the type of nutrient deficiency, the method of feature extraction has to be changed in the flow diagram. The captured images have to be preprocessed for the noise removal before applying the feature extraction step. In this work three features are taken under consideration first dead cell, second is the leaf area and third is leaf color. For the primary nutrients deficiency detection all these three features are common. The steps are explained in the respective sections for the specific feature extraction.

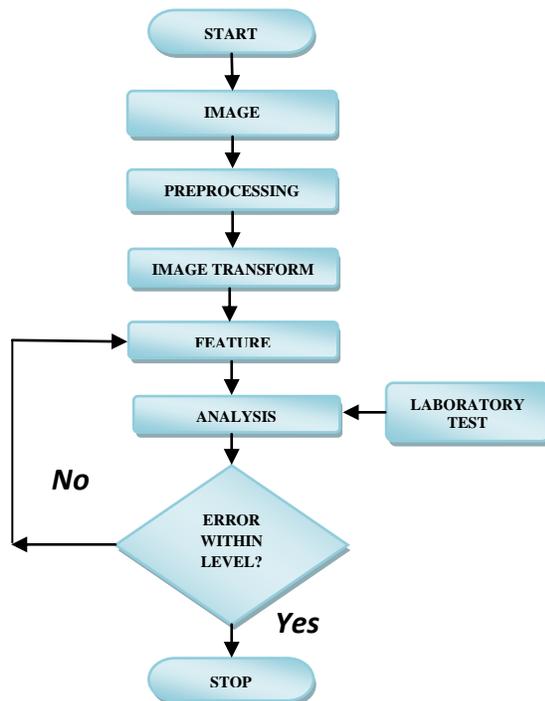


Fig.2.1. System Layout

2.2. Image Acquisition.

For the analysis the Cotton crop of AJIT brand is selected. The leaf whose deficiency is to be determined was placed flat on the white background. The camera was held horizontally to the plane of the leaf. The distance between the camera and the leaf was neither too closed nor too far; it was adjusted such a way that the photograph was covering only background and leaf as shown in figure 2.2. Nearly 15 such photographs of cotton leaves of same plot are taken for the analysis. These images are saved in JPEG format for further processing.



Fig.2.2.Captured sample Images of Cotton Leaves.

2.3 DEAD CELL DETECTION

Captured RGB image of healthy leaf is first converted in to gray scale image to plot the histogram. Same steps are carried out for the deficient leaf. From the obtained histogram shown in figure 3.1, following points are concluded.

1. Histogram of normal leaf is concentrated symmetrically at certain value on the gray scale.
2. Histogram of normal leaf has maximum peak which indicates frequency of occurrence of single color in leaf
3. Histogram of deficient leaf has non symmetric shape at certain values on gray scale.
4. Histogram of deficient leaf has smaller peak than that of normal.

From the above conclusions we can differentiate between normal and deficient leaf from the histograms.

2. 4 LEAF AREA MEASUREMENT

It's possible to calculate the area by using different approaches as when one thinks of the area the first thought comes to mind is physical dimensions of the object, but here the approach is different. The method is based on the pixel statistics. The reference coin of known diameter is used to find the area of leaf. First the RGB image of coin is converted in to gray scale and then in to binary image. The unit pixel area of the reference coin is calculated from the binary image, then this area is multiplied with the pixels belongs to the leaf whose area is to be calculated. In this method the leaf is separated in to three planes namely Red, Green, and Blue Plane respectively. The leaf consists of green color as a major component hence only the green components are measured using thresholding. The threshold value is obtained by trial and error technique. Once the green pixels are calculated the area can be easily calculated using the unit pixel area. The above procedure is repeated for the sample leaf. The results obtained for the sample leaf is compared with that of normal leaf to conclude the deficiency.

2.5 COLOR IMAGE SEGMENTATION

Leaf color is the most important feature that is used to quantify the Nitrogen and potassium deficiency. As the deficiency of nitrogen shows the pale yellowish green symptoms, and potassium shows reddish brown. The sample leaf image is segmented to obtain the required color. From the scatter plot count the different color pixels. Repeat the same procedure for the healthy leaf. Compare the pixel count of both leaves to obtain the amount of nitrogen deficiency. It is obvious that in deficient leaf the count of yellow and reddish brown color pixel will be more than that of healthy leaf. Estimation is done by using image **RGB to L*a*b* COLOR SPACE**.

The L*a*b* color space (also known as **CIELAB** or **CIE L*a*b***) enables you to quantify these visual differences. The L*a*b* color space is derived from the CIE XYZ tri-stimulus values. The L*a*b* space consists of a **luminosity 'L'** or brightness layer, **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. By choosing a small sample region for each color and to calculate each sample region's average color in 'a*b*' space. These color markers are used to classify each pixel. The CIE Lab color scale is approximately uniform color scale.

The CIELAB color space is organized in cube form. The L^* axis runs from top to bottom. The maximum for the L^* is 100, which represents the perfect reflecting diffuser. The minimum for the L^* is 0(Zero), which represents black. The a^* and b^* axes have no specific numerical limits. Positive a^* is Red. Negative a^* is Green, Positive b^* is Yellow, Negative b^* is Blue. Below is the diagram representing the CIE LAB color space.

The CIELAB color scale may be used on any object whose color may be measured. It provides a standard scale for comparison of color values.

3. RESULTS

Results obtained from above three steps are shown below

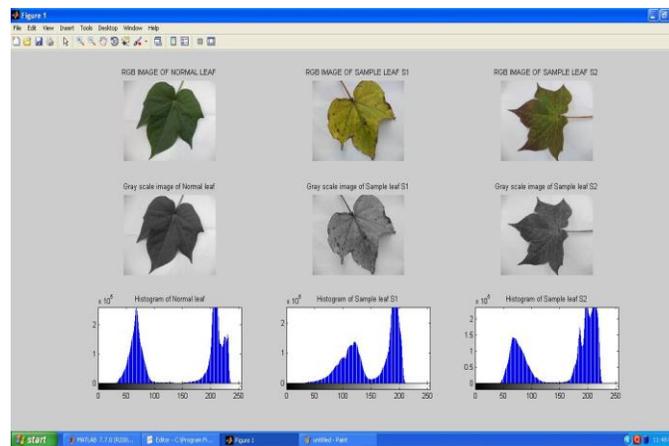


Fig.3.1: Results of Dead cell Analysis

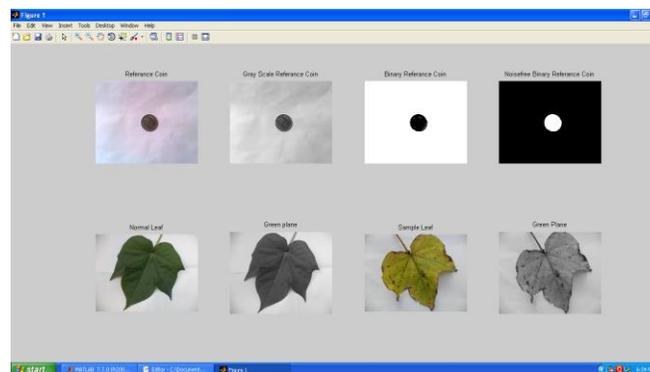


Fig.3.2: Results of Leaf area measurement

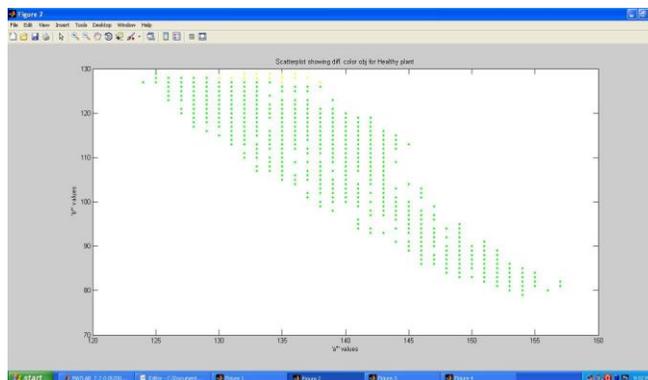


Fig.3.3: Scatter plot of Healthy Leaf Image

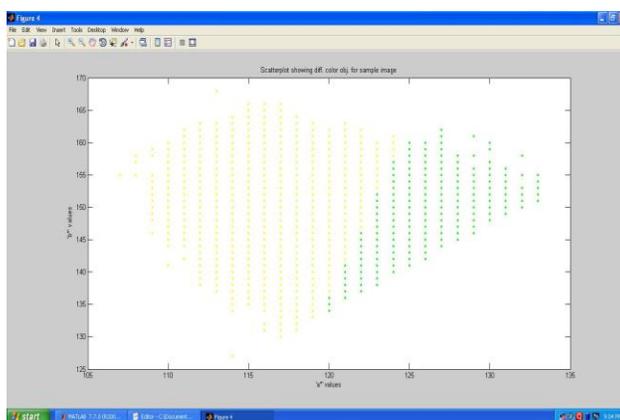


Fig.3.4: Scatter Plot of Sample Leaf Image.

4. CONCLUSION & DISCUSSION

The field analysis is done by using the methods discussed and the results obtained for different feature are summarized in the table 4.1 below. Nearly ten sample of another cotton lot are taken for the analysis. The area of Healthy leaf is found 53.31cm². In order to determine the percentage deficiency, it is required to take the average of values generated by the CIE LAB for ten to fifteen leaves. These results are compared with standard values to conclude.

Table 4.1: Field analysis Results

Sample No.	Area	Area Difference	% Deficiency	Remark
01	23.96	29.35	1.14	Deficient
02	30.22	23.08	2.66	Normal
03	47.30	6.00	2.85	Normal
04	43.23	10.07	3.28	Normal

05	32.42	20.88	0.12	Deficient
06	34.98	18.33	2.02	Deficient
07	32.28	21.02	1.03	Deficient
08	34.81	18.50	0.82	Deficient
09	19.65	33.66	4.78	Excess
10	27.03	26.27	3.81	Excess

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