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Detection and Analysis of Deficiencies in Groundnut Plant using Geometric Moments

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Abstract**—**We propose our genuine research of geometric moments which detects the mineral inadequacy in the frail groundnut plant. This plant is prone to many deficiencies as a result of the variance in the soil nutrients. By analyzing the leaves of the plant, we detect the visual symptoms that are not recognizable to the naked eyes. We have collected about 160 samples of leaves from the nearby fields. The images have been taken by keeping every leaf into a black box to avoid the external interference. For the first time, it has been possible to provide the farmer with the stages of deficiencies. This paper has applied the algorithms successfully to many other plants like Lady's finger, Green Bean, Lablab Bean, Chilli and Tomato. But we submit the results of the groundnut predominantly. The accuracy of our algorithm and method is almost 93%. This will again pioneer a kind of green revolution in the field of agriculture and will be a boon to that field.

Keywords**—**Component image, geometric moments, average intensity, average affected area, black box

I. Introduction

THE occurrence of diseases and deficiencies in plants is turning to be an alarming condition in today's agricultural world. As plants become victim of unsettled climatic, environmental and soil conditions, nutritional imbalance is observed in these sensitive plants. We have selected groundnut plant as it is explicitly important if the developing countries are considered, as in there, groundnut has to play an important role as oil and a food crop. China and India together are the world‘s leading groundnut producers accounting nearly 60% of the production and 52% of the crop area. Still, productivity levels in these countries are considerably lower, mainly due to number of production constraints such as I) The cultivation of the crop on marginal lands under rain fed conditions II) Occurrence of frequent drought stress due to vagaries of monsoon and III) Higher incidence of disease and pest attacks IV) Low input-use and V) Factors related to socio-economic infrastructure [1], [3].The groundnut plant primarily shows iron, zinc and magnesium deficiencies. Under conditions of prolonged deficiency of iron, the veins may also become chlorotic, causing the whole leaf to suffer from intervenous chlorosis, which is similarly seen in magnesium deficiency. Many enzymes require zinc ions (Zn++) for their activity and even, the chlorosis may be an expression of a zinc requirement for chlorophyll biosynthesis.

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Zinc deficiency is characterized by a reduction in intermodal growth and as a result, plants display arosetic habit of growth in which the leaves form a circular cluster radiating at or close to the ground [2].These visual symptoms mentioned above are our bank points which we use significantly as tools to get out the results.Work on this mineral neutralization mainly concern correct identification of the mineral or the dynamics of the deficiencies or determination of empirical damage functions due to such mineral deficiency [2], [3]. However, no study of some automatic system for determination of such mineral deficiency in this crop exists in the literature of this field. Because of lack of balance in mineral levels, some specific changes appear on groundnut leaves. In the present approach, we consider automatic analysis of color texture of images of groundnut leaves captured by digital camera towards determination of any possible deficiency in the balance of mineral levels affecting the plants. Although our preliminary simulation results based on the available samples (collected from Marathwada Agriculture University and the nearby areas of Pune and Parbhani) are persuading, it needs more extensive study based on a large volume of representative sample data. In the present study, we have calculated geometric moments of the leaves (discussed later in the paper [VI]). Three important micronutrients such as Zinc, Iron, and Magnesium are considered. Intensity variation and average area calculation of all these component images (Red, Blue and Green) gives us the stages of the deficiency and also the name of the deficiency. This feature selection approach seems to have some similarity with the human visual system since we do not consciously use any predetermined feature set for recognition of texture. This data is statistically espoused by the geometric moments of the images. Thus, the paper stands strongly with two statistical results hand in hand.

II. Previous Work

A. A Review of color, texture, and segmentation approaches

Texture and color information are often considered to be two useful features for classification of color texture images. A large number of research works are found in the literature on segmentation of image textures and also there exist a significant amount of works on segmentation of color images. But there is not much work done on color analysis and by simple algorithm finding the area affected and intensity differences gradually in the different stages of affected parts of the leaves. Two works on each of the above two segmentation problems include [4, 5] using texture information and [6, 7] using color information. However, not enough work has been done on component image separation using the color information present in the image and displaying even the stages of the deficiencies. Consideration of both texture and color for the purpose of image segmentation is also challenging [8]. Usually, color based separation i.e. separation of the component channels and extracting information from it separately gives us strong base to detect the difference in the intensities in the gradual stages. It stands more vibrantly as compared to the segmentation and texture methods.

III. Background

A. Effects of some mineral deficiencies on groundnut plant

Production of crop can be increased by studying and preventing the imbalance in the nutrient levels. Brief descriptions of effects on appearance of groundnut leaves in regard to deficiencies in the levels of three important minerals are described below [3].

Magnesium: A characteristic symptom of Magnesium deficiency is chlorosis between the leaf veins, occurring first in the older leaves because of the mobility of this element. If the deficiency is extensive, the leaves may become yellow or white. An additional symptom of magnesium deficiency may be premature leaf abscission.

Iron: As explained earlier, the low mobility of iron is probably due to its precipitation in the older leaves as insoluble oxides or phosphates, or to the formation of complexes with phytoferritin, an iron-binding protein found in the leaf and other plant parts (Oth et al.1996).The precipitation of iron diminishes subsequent mobilization of the metal into the phloem for long-distance translocation.

Zinc: The leaves become small and distorted, with leaf margins having a puckered appearance. These symptoms may result from loss of the capacity to produce sufficient amounts of the auxin-indole-3-acetic acid (IAA).In some species, the older leaves may become intravenously chlorotic and then develop white necrotic spots.

B. Theoretical Analysis

- The method of geometric moments makes this proper unique and original as it clearly distinguishes the gradual stages in the leaves and shows the increase in spots.
- As the pixel intensities change gradually, we can figure out these changes through geometric moments.
- As shown ahead in the TABLE 3, the values of moments go on increasing. This shows that the effect of deficiencies is aggrandizes gradually.
- Segmentation can only provide us with the name of deficiency and not with its stages. Other moments like Zernike, Complex, and Legendre unnecessarily increase the complexity in the process. The results we get through geometric moments are simpler and easier to understand formulation and implementation.

IV .Feature Extraction

The pixels in a color image are commonly represented in the RGB .In this approach, first we get the stages of deficiencies and then we gradually apply geometric moments algorithm to each leaf. This data can then be used by the device to tell the stage and type of deficiency of the leaf being tested. This shows better results and thus minimizing the need of complex algorithms like texture recognition, shape recognition [4], [5].

Pre-processed image is discriminated into its 3 components i.e. R, G, B components [6]. From the literature survey [7], [12], it is concluded and proved that there are particular stages of the deficiencies of groundnut leaves [11]. These deficiencies become much more significantly observable as it moves from previous to next stage. So to detect it at an early stage is key factor to be considered. For this purpose, average intensity for each component image is calculated with the help of the following formula:

$$\text{Average Intensity} = \frac{\sum f(i,j,k)}{T} \qquad (1)$$

where T is total number of count of leaf pixels in the image, and k can take values 1, 2 or 3 depending upon type of the component image it is observed that from one stage to another stage there is significant change in the average intensity values. Now, graph of such change in intensities for each stage is calculated.

The photos of leaves are taken by keeping them in the black box to avoid the variance in the light intensities every time. Moreover, the interference of external light source can be avoided as in [14].Now the leaf is apt for further processing. Experimental result of this part is discussed in the V section which deals only with the results. Actually, we get the stages roughly by simple R, G, B process. To strengthen that result, we apply geometric moments. Now, we have particular values for moments of stages. e.g.: 47 for Zeroth moment of stage 4. This helps us to sterilize the values and get onto deciding fixed values for each stage.

V.Geometric Moments

By another approach, the paper tries to support the results demonstrated by the previous approach. The geometric moments have been calculated till the fifth order. The difference between the geometric moments as we proceed along the stages helps us to come to a conclusion of a specific figure for a particular stage.

Geometric moments, also known as regular moments, are the first moments to be introduced and also the most common ones[18].For the images with (N x M) pixels and pixel density, f(x, y), the geometric moments m, with order n and m are defined as,

$$m_{nm}=\sum_{x=0}^{N-1} \sum_{y=0}^{M-1} x^n y^m f(x,y) \qquad (2)$$

where m and n are orders of the moment, x and y are the pixels and f(x, y) is the intensity of that pixel.

However, we have presented here only the central moments from the whole.

*Central moments:*To get moments that are independent of the object position, central moments are calculated. Central moments [15],

$$m_{nm} = \sum_{x=0}^{n-1} \sum_{y=0}^{m-1} (x-x_0)^n (y-y_0)^m f(x,y) \qquad (3)$$

where f (x, y)=intensity of the image at (x, y) position

$$x_0=\frac{m_{01}}{m_{00}} \quad \text{and} \quad y_0=\frac{m_{10}}{m_{00}}. \qquad (4)$$

The three invariance values that moments determine are not useful in the context of leaves like translation, rotation etc. The reason being, as we have designed a black box, problem of scale variance does not occur [16], [17].The distance between the camera and the leaf is fixed every time we take the photo. Variance in the translation or orientation does not affect the process as the algorithm considers the whole image and not a mere part of it [13].Moments of orders zero, one and two of a probability density function represent the total probability, the expectation, and variance respectively. In mechanics, these moments of a spatial distribution of mass give the total mass, the centroid mass, and the inertia values respectively [21].

There are various types of moment functions in image analysis:

- Fast Computation Method: This immediate digital approximation of intensity values over the image region has been adopted in this paper.
- The Delta Method: The delta method for computing the moment functions of a binary image using only the boundary points of the image region, was introduced by Zakaria[224].
- The Rectangular Integration Method: The method of rectangular integration uses the same image representation as in the delta method, but performs the integration over rectangular regions around the image.
- The Contour Integration Method: The contour integration method uses the famous Green's theorem to reduce the two–dimensional surface integral of the moment functions to a single-dimensional contour integral along the boundary points. The next section will discuss its result.

But, opting for these complex moments would make the process more difficult to understand. If we can get prudent and unclouded results with fast computation moments method, it would be better to avoid going for the above complex methods.

VI. Implementation Details

The computation image moments has to be highly accurate to retain the various properties of moment transformations and to have the desired characteristics of moment invariants. The speed of computation is also an important factor. The requirement for real-time processing has necessitated hardware implementations of moment based algorithms.A method to compute the two-dimensional moments using recursive filters is given in [22], [23].

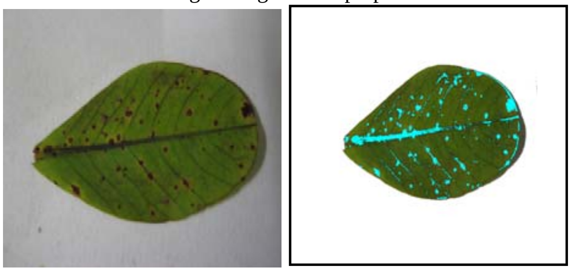
$$m_{pq} = \sum_{i=1}^{N} i^p \{\sum_{j=1}^{M} j^q f_{ij}\} \quad (5)$$

Where i, j denote the row and column indices respectively, and f is the intensity value at the pixel (i,j).Here M denotes the total number of rows in the image, and N the total number of columns .The implementation of this algorithm is based on the fact that if the sequence f_n,n=0,1,2,....,N is applied to the input of a digital filter with impulse response h(n)=n^ku(n).But this being directly established in softwares, there is absolutely no need to go for the filters separately. The algorithm was implemented in MATLAB and C++ on a machine with Intel i3 processor and 2GB RAM.

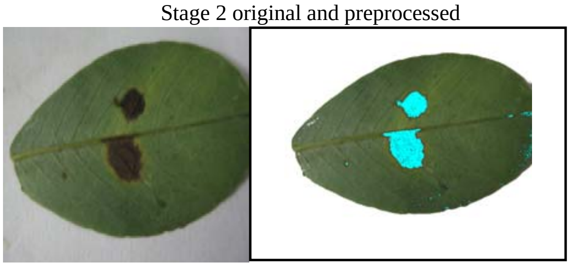
VII. Results

Now, this section will discuss the results of the database collected by us, comparing it with the database of Marijuana Plant database [10].

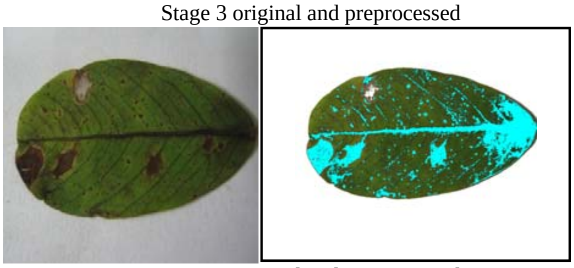
Stage 1 original and preprocessed



Stage 2 original and preprocessed



Stage 3 original and preprocessed



Stage 4 original and preprocessed

A. Feature Extraction:

As discussed earlier, this part gives us the stages of the deficiencies and the stages of the same .It can be seen from the table below that as we proceed through the stages, the R, G values increase and the B intensity comparatively decreases. The affected area chart can help us in determining the type of deficiency.

TABLE I
AVERAGE COMPONENT INTENSITY FOR EVERY STAGE

Stages	Average intensity		
	R	G	B
S-1	59.8172	77.1781	40.1972
S-2	69.026	84.6128	42.7297
S-3	74.1221	90.7635	53.6972
S-4	88.2041	95.6251	47.8408

TABLE II
% AVERAGE AFFECTED AREA OF LEAVES THROUGH STAGES

Leaf	% Average affected area			
	Stage 1	Stage 2	Stage 3	Stage 4
11	2.7537	8.562	6.9589	8.615
21	48.633	11.4437	7.8826	16.3571
31	0.3193	17.7717	5.899	19.4967

B. Geometrics Moments

Here, variance in the moment properties can be seen as we proceed through the stages. Moments of the order 0,1,2,3,4 and 5 have been formulated for each stage that we got from the previous results .The values of first 4 moments have been given which clearly show the gradual increase from the first stage to the last one.

Calculations: For example, to get g_{00}, we put n=m=0 in the formula given on page 3 of this paper (equation (1)). We get m_{00} which is nothing but g_{00} in the table below.

TABLE III
FOUR GEOMETRIC MOMENTS VALUES FOR ALL FOUR STAGES

Mom.	S-1	S-2	S-3	S-4
g_{00}	18	21	23	47
g_{01}	34392	41696	62448	89581
g_{02}	77.78M	91.36M	105.61M	200.54M
g_{11}	43	52.76	60.59	71.47

S-1: stage 1
g_{00}: Zeroth central moment.
Mom: Moments

C. Graphs

Graphs that explain the whole result of intensity differences, average affected area differences, and the geometric moment differences between the stages are shown below. Through graphs (Fig 1), it becomes easier to know the exact changes in the leaves through stages, we are talking about.

The gradual increase in R & G intensities through the stages and relative decrease in the B intensity is shown in the first graph. Second graph (Fig 2) shows the increase in values of the moments through the 4 stages.

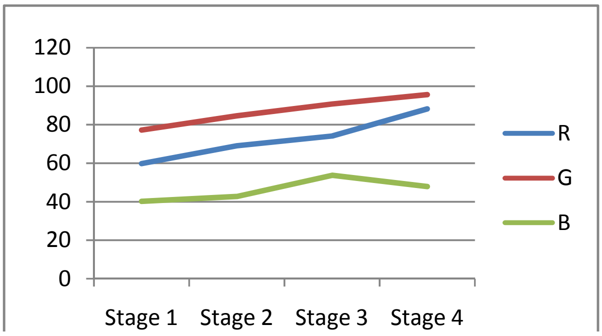


Fig.1 Intensity Variation along the Stages

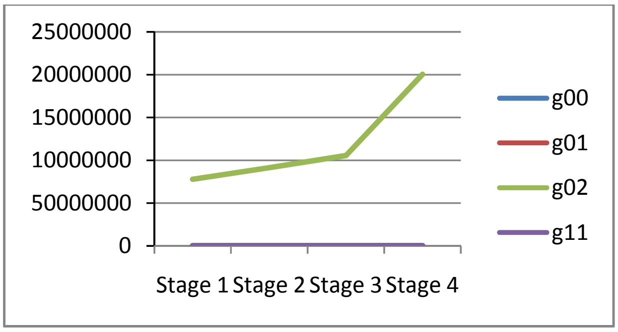


Fig. 2 Geometric Moments through Stages

VIII. CONCLUSION AND FUTURE WORK

In the present article, we have presented the result of our pilot study towards application of an image analysis (particularly, color analysis) technique for diagnosis of deficiencies in the mineral levels affecting a groundnut plant. The two parts of the paper statistically support each other. However, to study the robustness of the present scheme, a more extensive study on the basis of large training and test sets is necessary. We have even planted seeds of the plant in different environment and soils to support this field work with thorough implementation. But it is expensive to develop the required database.

This work has been actually implemented on a large scale in the farms of Maharashtra, India with the help 2 agricultural universities. We have actually helped 58 groups of farmers; personally recommended them the right chemical for their crop at a very initial stage. Both the methods of experimentation are analogous to each other and thus, high amount of accuracy is observed in the whole implementation. We look forward to getting such a database for further study. Also, we feel the requirement of studying several other color analysis methods for the present classification job. Now, it's time for agricultural revolution supported by electronics and computing.

No device gives you the stage of the deficiency. An advantage of designing such a system is that in near future it may be possible to embed the same in Personal Digital Assistants (PDAs), which we wish to name as '***SHIVAAR'***, Indian name for a farm. In this connection, it may be noted that the increasing availability of high performance, low priced, camera phone devices has already become popular among the very common people all over the world including India. Thus, in future, a farmer with the help of such a camera phone will be able to investigate on some regular basis whether his crops are suffering from loss of balance of mineral levels or a disease and if necessary can take required measures without consulting a plant pathologist and this will certainly save his money and time.

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