International Journal of Computing Algorithm
Volume: 05 Issue: 02 December 2016 Page No.84-87
ISSN: 2278-2397

Detection of Nutrient Deficiencies in Plant Leaves using Image Processing

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Abstract—In this paper, we suggest a model for the automatic detection and classification of nutrient deficiencies in plant leaves. In an agricultural country like India, farmers are facing lot of problems in detecting the causes for the diseases in plants. Only when the causes are sorted out, the solution can be found to treat them. With naked-eye observation it is difficult to classify the deficiency present in leaves. So with the help of image processing algorithms, we have proposed a model to detect the type of deficiencies in the leaves. The color and texture features are used to recognize and classify the deficiencies. The combinations of features prove to be very effective in deficiency detection. This paper presents an effective method for detection of nutrient deficiencies in leaves using color-texture analysis and k-means clustering.

Keywords - Macro nutrient, nutrient deficiency detection, texture, clustering algorithm.

I. INTRODUCTION

Nutrients play a major role for the plants to grow healthy. The plants require all nutrients in the correct proportionate. These nutrients help the plants to grow and reproduce in a healthy way. If malnutrition exists in the plants , there will be symptoms like unhealthy leaves. Malnutrition occurs if the nutrients goes below or above the needed quantity. Plant Nutrients are generally classified into macro and micro nutrients. Macro nutrients are those which are required in relatively large amounts. Micro nutrients are needed in small amounts. The nutrients such as calcium, nitrogen, potassium, magnesium, sulphur and phosphorus are the major nutrients. The elements such as boron, manganese, iron, copper, zinc, chlorine are the micro nutrients. These micro nutrients are of little importance.[1]

II. LITERATURE REVIEW

Numerous techniques and methodologies are used in this area is reviewed and briefly described here. Various papers had been published for disease detection in plant leaves. But more research is yet to be done in the topic nutrient deficiency detection of leaves. Large number of researches is focused on disease detection rather than deficiency of major nutrients [8]. In this paper only the macronutrients are analysed and their deficiencies are identified.

A. Need for the nutrients

One of the component of nitrogen is the chlorophyll. So nitrogen provides green colour to the leaves. It helps to improve the leaf crops quality and also to bear healthy fruits. If this nutrient is deficient , it affects the overall growth of the crop. The leaves colour turns from light green to yellow[2][9]. Phosphorus another important nutrient plays the role in root and cells development. It also increases protein production [2][9]. Potassium is also a necessary element for plants. It plays the key role in biochemical and physiological functions. It helps the cuticle to grow thicker. So it prevents from water loss and disease [1][9]. Sulfur is essential to maintain dark green color, kindle seed production, and stimulate root and general plant growth and part of proteins, amino acids, and vitamins important in respiration.[9] Calcium is a building block of cell walls, and promotes root and leaf development and activates enzymes involved in plant metabolism.[9] Magnesium is the building block of chlorophyll. It takes care of the photosynthesis in plants.[9] So the deficient symptoms for the macronutrients according to the literature are discussed below.

B. Deficiency Symptoms

1) Nitrogen (N)

Nitrogen deficiency turns the green plants to become pale and yellowish green. The stalks become weak. Symptoms of this deficiency will occur on older and lower leaves. The leaves occurs as v-shaped in yellow color starting from the tip and goes down the midrib [2]. It may have stunted growth and shorter internodes, small pale yellow leaves. Plant may be light green and the older leaves are affected first.[3]

2) Phosphorus (P)

Phosphorus deficiency usually occurs on young plants. The leaf tips become reddish purple and margins appear on older leaves. Phosphorus deficient plants normally appear dark green.[2][5].They may have red or purplish color leaves, especially undersides and death of tissue or necrosis may follow. [3]

3) Potassium (K)

Potassium deficiency occurs on the lower leaves first. The symptoms are necrosis of leaf margins and they appear yellow.[2] Yellow-streaked leaves, followed by browning and death of tips and margins. Older leaves are affected first[3]

4) Sulfur (S)

Sulphur deficiency symptoms occurs on small plants. The leafy parts of the tree appear yellow. The young leaves becoming yellow can be noticed with this deficiency. Generaly yellowing of the whole plant starts with the younger leaves and plants may be light green. Plants may be prevented from growing or developing properly and exhibit delayed maturity. [3]

5) Calcium (Ca)

Calcium deficiency occurs in plants like corn. The tips of the leaves get stuck to the next lower leaf and appears one after another like a ladder.[2] The older, larger leaves just above the bottommost ones will show the first symptoms. Yellow/brown spots occur, which are surrounded often by a sharp brown outlined edge.

6) Magnesium (Mg)

Magnesium deficiency appears in the lower leaves. These leaves are yellowish and white near the interveins. [2] There will be yellow marking spots between veins of older leaves while veins remain green. Yellow areas may turn brown and then die. Leaves look burnt from the tips. Yellowing also may occur on older leaves. [3] Instead of mixing all different techniques at once, color histograms have been used to retrieve the major color contents of the image. Texture segmentation is used to identify the desired markings or spots based on the texture configurations of an image. Texture analysis is analyzing the image by their texture content. The image regions are characterized and analyzed by the texture features such as their roughness, silkyness etc.[7]

The texture analysis uses the algorithm named co-occurrence matrix method [7] and K-means Clustering method. The algorithm K-means clustering attempt to classify pixels based on a set of features into K number of classes. The sum of squares of distances between the objects has been minimized and the corresponding cluster or class centroid for doing classification. However, in this work K-means clustering has been used and the leaf image is separated into four clusters in which one or more clusters hold the disease. [7]

III. PROPOSED METHODOLOGY

In our proposed approach, to detect the nutrient deficiencies in leaves the properties such as colouring and texture of leaves must be an analysed. So the properties for nutrient deficiencies are stored in a database called training database. The properties of leaves which have to undergo the deficiency detection process are stored in a database called testing database. A methodology called Nutrient Deficiency Detection using image processing have been proposed. The framework of the proposed method is shown in Fig1.

A. RGB image acquisition

Initially the images of various types of leaves are captured using a digital camera.

B. RGB to HSI transformation

The RGB images of the leaves are represented in Hue Intensity Saturation (HIS)color model. The HIS color space representation is widely accepted as it is related to human perception[13]. The Hue component refers to the dominant color of the image. Saturation gives the corresponding purity. It is the amount of white light added to the hue value. Intensity means the amplitude of the light present [12]. So in this paper the color space is transformed from RGB to HSI representation. After the transformation, the H component is taken into account for further analysis.

C. Image segmentation

This step is divided into two parts

1) Masking green pixels: The pixels which are mostly green are identified first. Then a threshold value is calculated such that if the green part of the pixel intensity is less than the computed threshold value, those pixels are to be masked. The red, green and blue components of these pixels are made zero[1]. The green pixels are masked so that they need not be taken for further analysis.

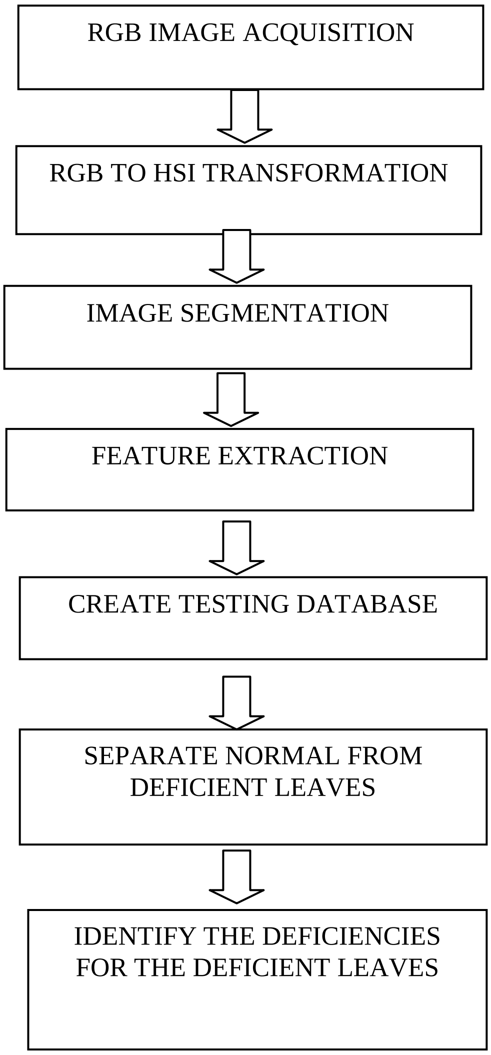

Fig. 1. Nutrient Deficiency detection Methodology

2) Extract useful segments: The infected portion of the leaves are then segmented into patches of equal size. The size of the patch is chosen such that the significant information is not lost. All segments do not have useful information. So the patches having more than 70 percent of significant information are considered for further analysis. For segmenting the essential parts of segments such as shape of leaf tips, interveins , region between interveins, spots etc statistical region merging algorithm is used. [6]

D. Feature Extraction

The main features extracted for consideration are: Texture, Color

1) Texture: The texture of leaves are extracted using statistical region merging . They may include features such as death of tips and margin, curling, reddish purple tip etc. These features are stored in the testing database.

2) Color separation: The HSI (Hue, Saturation and Intensity) color model is used for representing the colors of the images. The color histogram represents the distribution of color in images. Here we compute the intensity of the colors present in leaves and represent them in a histogram[10][12].

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Volume: 05 Issue: 02 December 2016 Page No.84-87
ISSN: 2278-2397

Also, the intensity of each color is stored in testing database in percentage.

E. Creating Testing database

The features of the leaves extracted in the previous phase are stored in the testing database. For the proposed method the features such as types of leaves and color of the leaves in appropriate regions and the difference in their texture are identified for each nutrient from the literature studied. They are recorded in the testing database for comparison with the experimental leaves.

F. Separate Normal and Deficient leaves.

The K means clustering algorithm[11] is used for clustering. Those leaves with maximum pixels masked are considered to be normal. The others which have values in the histogram are classified as deficient. Here clusters will be classified in two classes. Normal, Deficient

G. Identify the deficiencies for the deficient leaves

Only the deficient clusters from the previous step are taken as input for this step. Here K-NN algorithm is applied to identify the deficiencies[11]. The features of leaves in the testing database are compared against the training database. If maximum features match with the features of a particular deficiency, then they are affected by that deficiency. Using this technique, the clusters are formed for the different deficiencies. Hence, finally the leaves are classified and fall into either one of four groups (ie) potassium, calcium, nitrogen, magnesium.

IV. RESULTS AND DISCUSSION

The training database consisting of the nutrients and their deficiency symptoms is created as in table 1. [1][2][3][4][9] The samples taken for deficiency detection of nutrients is given in Table II. The sample leaves are converted into their hue, saturation, intensity images. The colors present are extracted from these images and recorded in the testing database. Table III shows the hue, saturation and intensity components of the samples. The Hue component is taken for further analysis.

Table 1: Training database

Nutrient	Deficiency Symptoms			
	Type of leaves	*Color*	*Region*	*Texture*
Calcium	New	Yellow / brown	Spots	Death of leaf tips
Nitrogen	Old	Pale yellow	Whole	
Pottasium	Old	Brown	Edge/ segments	Curling of leaf tips
Magnesium	Old	Yellow	Between leaf veins	Leaf tips look burnt
Sulphur	New	Yellow	Whole	
Phosporus	Old	Reddish purple	Leaf tips & margins	Leaf tips look burnt

The Hue components computes the colors present in the leaves in percentage. Using this value and comparing with training database, the appropriate nutrient which is deficient in the leaves is found. The following Table IV lists the samples and their deficient nutrients found using the proposed approach.

Table II. Testing Database - Samples Taken

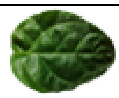
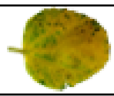
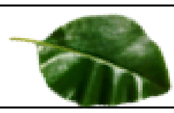
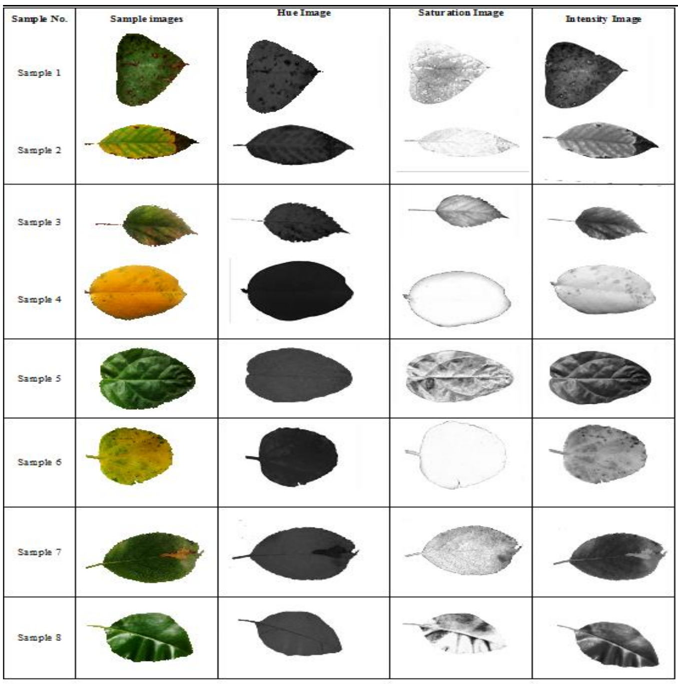
Sample No.	Sample images	English Name	Botanical Name
Sample 1		Beans	Phaseolus vulgaris
Sample 2		Custard Apple	Annona reticulata
Sample 3		Hibiscus	Hibiscus rosasinensis
Sample 4		Ixora	Ixora coccinea
Sample 5		Jasmine	Jasminum sambac
Sample 6		Hibiscus	Hibiscus rosa-sinensis
Sample 7		Rose	Rosa chinensis
Sample 8		Sapodill a	Manilkara zapota

Table III. Testing database – Extraction of colors using hue, saturation, intensity images



Volume: 05 Issue: 02 December 2016 Page No.84-87
ISSN: 2278-2397

TABLE IV. Deficient nutrients for the samples taken

Samples	English Name	Nutrient Deficient
Sample 1	Beans	Calcium
Sample 2	Custard Apple	Magnesium
Sample 3	Hibiscus	Phosphorus
Sample 4	Ixora	Nitrogen
Sample 5	Jasmine	Healthy leaf
Sample 6	Hibiscus	Sulphur
Sample 7	Rose	Potassium
Sample 8	Sapodilla	Healthy leaf

V. CONCLUSION

Nutrient Deficiency detection is a system which identifies the unhealthy leaves and the nutrients which are deficient in them. This makes use of the image processing technique. Colors and texture of leaves are analysed for detection. The proposed system consists of preprocessing, feature extraction, segmentation , training and classification and finally identification. This paper proposes a valuable approach which supports the accurate detection of nutrients which are deficient in the plant leaves. This work can further be extended focussing on texture analysis. More efficient algorithms including more features of the texture can be developed.

References

[1] Guide to Symptoms of Plant Nutrient Deficiencies ,Shanyn Hosier,Instructional Specialist Urban Horticulture Lucy Bradley, Agent Urban Horticulture
[2] Nutrient deficiencies row crops ISU.pdf, IOWA state university, extension and outreach
[3] Nutrient Deficiency Symptoms Barbara J. Bromley, Mercer County Horticulturist 10
[4] John Sawyer, Department of Agronomy. “Nutrient Deficiencies and Application Injuries in Field Crops” in IOWA State university (University Extension) IPM 42 Revised July 2004.
[5] Disease and Nutrient Deficiency Detection in Cotton Plant Ashish Miyatra, Sheetal Solanki ijedr, Volume 2, Issue 2, 2014
[6] Statistical Region Merging Richard Nock and Frank Nielsen, IEEE transactions on pattern analysis and machine intelligence, vol. 26, no. 11, November 2004
[7] Remote Area Plant Disease Detection Using Image ProcessingSabah Bashir, Navdeep Sharma IOSR Journal of Electronics and Communication Engineering (IOSRJECE) Sep-Oct2012
[8] A Survey on Disease and Nutrient Deficiency Detection in Cotton PlantAshish Miyatra , Dulari Bosamiya, Nilesh Kamariya IJRITCC | November 2013
[9] Nutrient deficiencies in export tree and food crops: literature review and field observations Article · January 2000 Alfred E. Hartemink and R. Michael Bourke
[10] A Review of Image Processing for Pomegranate Disease Detection Manisha A. Bhange, Prof. H.A. Hingoliwala, International Journal of Computer Science and Information Technologies, 2015
[11] A Review paper on : Agricultural Plant Leaf Disease Detection Using Image Processing Prof. Atul Shire,Prof.Umesh Jawarkar, Mr. Manoj Manmode , International Journal of Innovative Science, Engineering & Technology jan 2015
[12] Automatic detection and classification of plant disease through image processing, Mr. Pramod S. landge, Sushil A. Patil, Dhanashree S. Khot,Omkar D. Otari, Utkarsha G. Malavkar IJARCSSE 2013
[13] Gonzalez, R., R.E. Woods. 2008 Digital Image processing. Third edition , Pearson Education, Prentice-Hall, Inc.