Android Based Mobile Application to Estimate Nitrogen Content in Rice Crop

Navdeep Kaur*, Derminder Singh*

*Schoolof Electrical Engineering & Information Technology, Punjab Agricultural University
PO Box 141004, Ludhiana, India

Abstract - *The color of leaf corresponds to nitrogen deficiency status of that particular crop, farmers compares color of leaf with Leaf Color Chart (LCC) in order to estimate the need of nitrogen fertilizer of their crop. However the ability to compare leaf color with the LCC varies from person to person that affects the accuracy of final result. This paper proposes a mobile-device based application called "mlcc". Main idea is to simultaneously capture and process a 2-D color image of rice leaf, thus eliminating the expensive external components, reducing the human color perception and results in achieving high color accuracy. This android-based application can be correctly identified all the important 6 green color levels of rice leaf.*

Keywords— *Image processing, Leaf color chart, Android studio, digital camera, rice field.*

I. INTRODUCTION

The main basic cause for high production cost in any crop farming is fertilizers. After passing a very long time, still farmers apply fertilizers on plant just based upon the date of seeding and not according to its requirement. But now this traditional farming is being not accepted by the agricultural technology researches. They introduce precision farming that describes that the production inputs (seed, fertilizer, chemicals etc.) should be applied only at a time that are needed for the most economic production in order to obtain more economical gain (Gholizadeh*et al* 2009).Precision agriculture is the start of a revolution in resource management based on information technology that is bringing agriculture into the digital and information age. It leads to better utilization of nutrients according to actual requirement of soil. It involves integration of modern technologies including geographic Information Systems (GIS), Global Positioning Systems (GPS) and Remote Sensing (RS) technologies that allow farm producers to manage within field variability to maximize the cost-benefit ratio, instead of using the traditional whole-field approach.

Nitrogen and chlorophyll are the main limiting factors in the growth of plants. They are also the most crucial parameter in managing agricultural, on-point source pollution. Deficiency of these two may cause lower or unhealthy production. It mostly affects the cost of the crops, the recovery efficiency of N fertilizer in the crop field and the risk of residue nitrate pollution in water. These may have led to several tools and management plans in monitoring the nitrogen status in the particular crop so that the farmers can apply the efficient amount of fertilizer to their crops. It is realized that amount of chlorophyll content in a green leaf is strongly correlated with the leaf N concentration; one can use a chlorophyll meter tool, which can generate a simple, fast and non-destructive result for evaluating N levels and detect N stress in crops. But it is a costly tool and also requires two optical sources with different operating wavelengths during well controlled operation. Nowadays, a visual scanning of the color of the crop leaf is the cheapest way for detecting N status in the crop which is LCC (Leaf Color Chart) that was first developed by Furuya (1987). It has been modified into 6-panel and a compact 4-panel LCC. Many countries have promoted the LCC because of their less cost. But incorrect visual reading of colors from LCC via naked eyes and the fading of color charts could often occurs, resulting in improper application of N fertilizer. This is the main limitation of LCC.

With the rapid growth of today smart mobile devices such as cell phones and tablets, simple optical inspecting tools such as an illumination meter scope can be realized. There are also free application programs available for analyzing color of the object(Google play,2013) and specific application programs for measuring the color of soil(Gomez-Robledo *et al.*,2013). So, with the concentration of the leaf color level, we propose and show a mobile phone-based color analyzer for estimating the color level of the rice crop leaf for N estimation. As N estimation of rice crop with LCC is generally performed in the day-time, we use natural light to illuminate the crop leaf, thus eliminating the additional light sources. Our key idea is to capture and process the 2-D optical data reflected from the rice crop leaf and generates the result of what amount of nitrogen deficiency is present in that leaf . So, according to the need of crop, the farmer may add the N fertilizer. Other key feature includes simplicity in design and ease of implementation.

II. PROPOSED MOBILE DEVICE-BASED CROP LEAF ANALYZER STRUCTURE

The proposed mobile phone-based crop leaf color analyzer architecture is shown in Fig 1. It consists of only a mobile device. The cell phone can be a PDA and a gadget furnished with a back camera, for example, a tablet. Sunlight shining over the crop field is automatically used as the illumination light. It illuminates the leaf. The mobile device having the proposed application is set is such a manner that the crop leaf is in the field of view of mobile device camera. In this way, the crop leaf is captured under the environmental condition.

Fig 1 Proposed mobile device-based rice leaf analyzer structure for nitrogen estimation

From fig 1, because the captured image is in red, blue and green format, analyze the color visibility (CV) of the image. In addition, as the leaf during investigation is in one color tone from light green to the dark green. For this, there is a method in android studio software tool in which application is developed for getting the only green pixels of the whole image and processing is takes place only on those pixels. CV in this work is defined as

$$CV = (Gs * 100)/255 \quad eq.(1)$$

Here, G_s is the average color value of all the green pixels present in the captured image. The calculated CV value will be correlated with the color level of the crop leaf from a standard LCC.As a result, N status and amount of N fertilizer can be easily estimated by our mobile-device-based crop leaf color analyzer. Because G_s is always smaller than 255 then CV is varied between 0 to 100. So, darker green colors associated with higher N in the leaf leads to lower CV values.

III. IMPLEMENTATION

A. Hardware

A field deployable model of cell phone based crop leaf shading analyzer is appeared in fig 1. Here, utilizinga Samsung's brilliant cell telephone model galaxy A3 inserted with a Quad-core 1.2 GHz Cortex-A53, 1GB RAM and Android OS, v4.4.4 (Kitkat), upgradable to v5.0.2 (Lollipop). Its computerized shading camera contains 540X960 pixels. A "PhotoCrop" tool is used to crop the clicked images.

B. Software

The cellular telephone based application project is created under JAVA language using Android Studio 1.5 version.The application program call "mlcc" has 7.23 MB of size and is perfect with Android 4.4 and upto 5.0.2 (Lollipop). The "mlcc" application system is intended to control the portable camera to catch a 540x960-pixel picture of crop leaf. When picture is clicked that inalienably contains picture locales related the crop leaf, the CV esteem from Eq. (1) and its relating leaf shading level are resolved.With the decided leaf shading level,the measure of N manure can be proposed in view of crop specialists or database put away in "mlcc" application program."mlcc" application project is planned and created in view of easy to use. The farmer simply clicks the picture of the leaf. Then crop the leaf area from that clicked picture. After that, he has to upload that cropped picture in the application. Now, by clicking on "Check nitrogen" button, average RGB of pixels of captured image is compared with the average RGB of pixels of the database samples. The comparison is not showed on the touch screen of the cell phone amid the genuine operation. Once the CV is discharge mined, its related leaf shading sample and the amount of deficiency of greenness (nitrogen) are displayed on cell phone's display as appeared in fig 2.

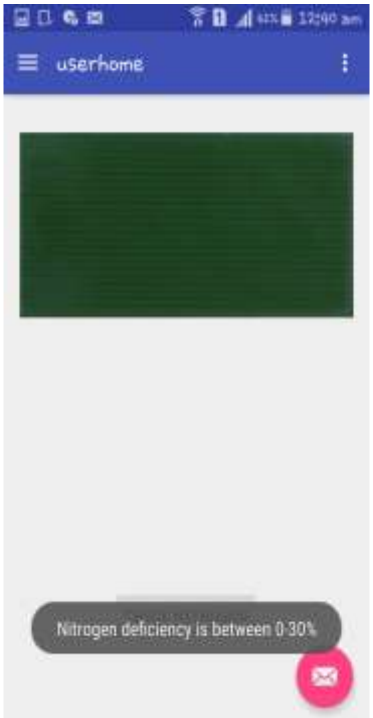

Fig 2 Result Screen

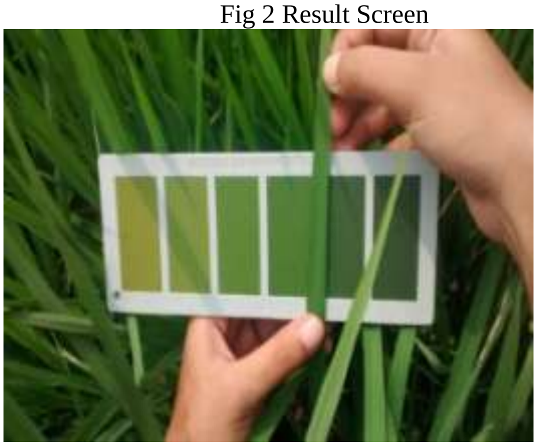

Fig.3 6-panel LCC

IV. CALIBRATION

In this segment, utilize a 6 shading board LCC 2001 releases from the International Rice Research Institute as reference shading levels shown in fig 3. This LCC is captured under day light in the Punjab agricultural University field area during 8:39AM to 1:21PM by using "mlcc" application program keeping in mind the end goal to at first ascertain all CV values connected with all shading levels of LCC.

To perceive how CV values from the LCC match the crop leaf shading in the genuine crop field, we go torice crop field in Punjab agricultural university, Ludhiana. Taking into account the fix time techniques for the crop in the tillering stage, we can quantify CV estimations of genuine crop leaves that match the shading levels of 1, 2, 3, 4, 5 and 6. Understanding that the shade of regular sunlight at every time has an influence to the shading perusing and its related blunder originates from the distinction of shading perusing between instrumental and visual shading estimations. Randomly select 5 leaves from the same field to test shading level. The completely extended leaf is chosen for assessing the measure of N compost since this leaf best reflects the N status. The images of selected leaves were clicked from different distances and at different times of the day. The results are compared with the nearby color level of images of leaf color chart clicked and processed by the developed application. The center portion of crop leaf is set on the LCC for looking at the shading level without disengaging and obliterating the leaf. Because of the distinctions in light intensity and also the distinctions in the LCC surface and the genuine crop leaves, the deliberate CV qualities are higher than ones acquired specifically from the LCC. The deliberate CV worth is likewise dropped more quickly from the genuine crop leaves than from the LCC.

A. Parameters affecting the results

The factors that are being considered while taking the readings are

- Day real time
- Distance between subject & camera

Formula to calculate percentage error is

$$[Captured\ leaf\ image\ reading - captured\ LCC\ card\ image\ reading] * 100/Captured\ LCC\ card\ image\ reading \quad Eq.2$$

1) On the basis of distance parameter:

The second parameter that may affect the readings is the distance that means at what distance user has to click the picture of an image. Here, it is concluded that if the farmer approximately take the distance of 20cm between the subject that is rice leaf and camera then approximately accurate results will take place.

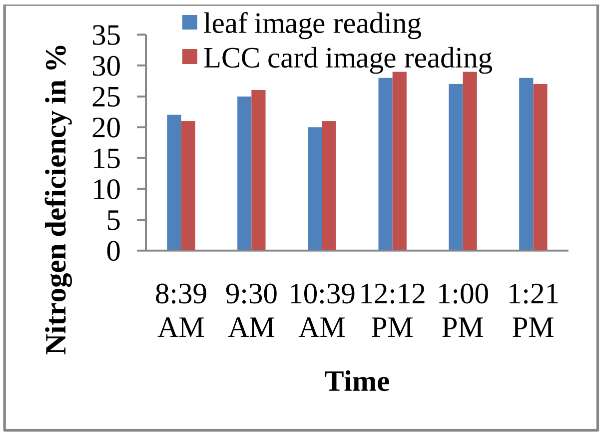

Fig. 4.1 Comparison between Captured Image reading and Captured LCC card reading at 20cm

4.1.2 On the basis of time parameter

As the main factors that are being considered while taking the readings are the time and distance between subject and camera. So, here images of leaves had been clicked on same day but on different timings between 8:39AM to 1:21PM. The results on the basis of time parameter are as follows:

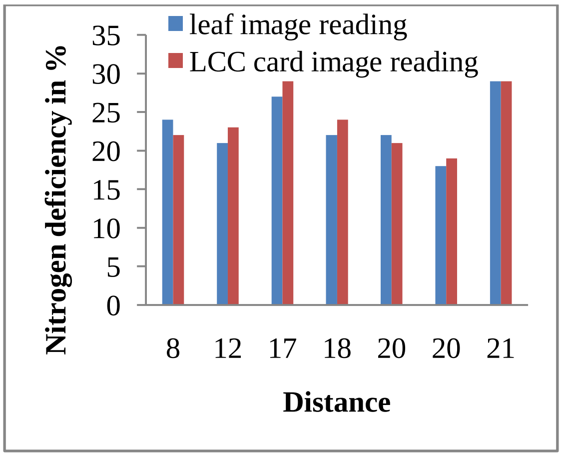

Fig. 4.2 Comparison between captured leaf image reading and captured LCC card image reading at 8:39 AM

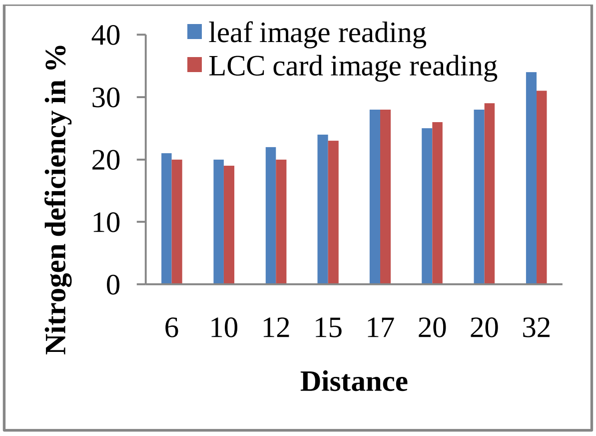

Fig. 4.3 Comparison between captured leaf image reading and captured LCC card image reading at 9:30AM

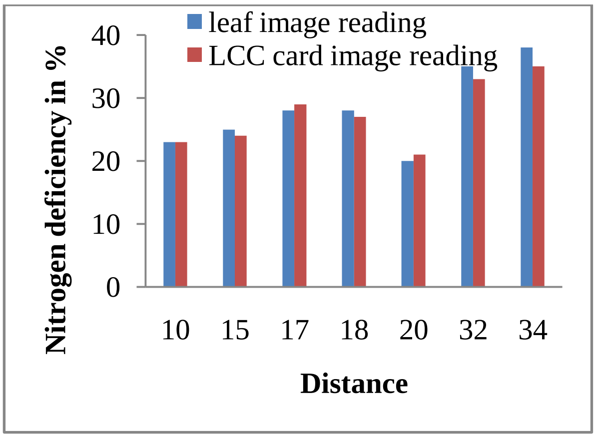

Fig. 4.4 Comparison between captured leaf image reading and captured LCC card image reading at 10:39AM

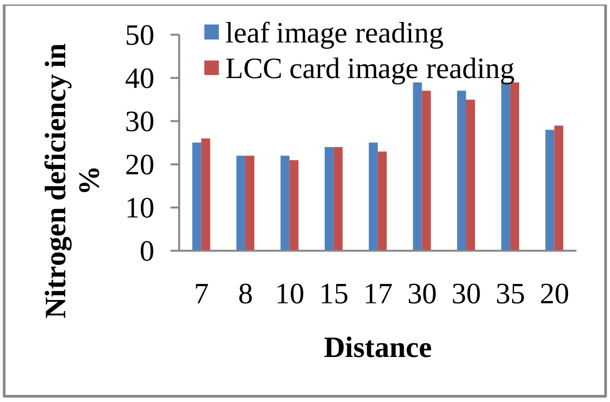

Fig. 4.5 Comparison between captured leaf image reading and captured LCC card image reading at 12:12 PM

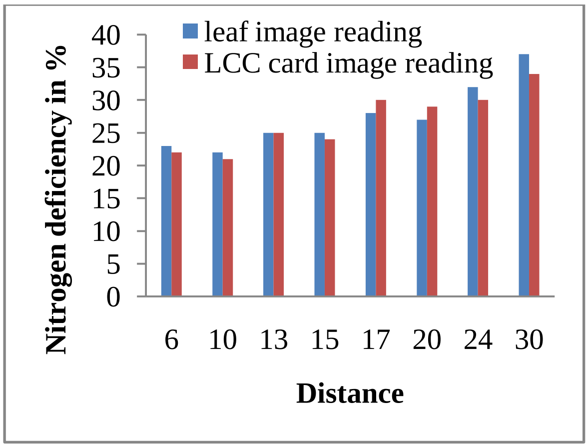

Fig. 4.6 Comparison between captured leaf image reading and captured LCC card image reading at 1:00 PM

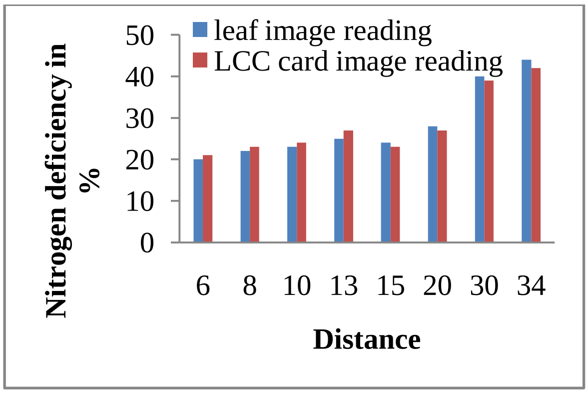

Fig. 4.7 Comparison between captured leaf image reading and captured LCC card image reading at 1:21 PM

On the basis of time, it can be watched that with the increase in time, it readings will be changed. As a result minimum percentage error calculated by the formula shown in eq.2 occur between 9:30 AM to 10:39 AM with distances 15-20cm.After 12, because of sunlight the readings will be changed and more error will occur.

V. RESULTS AND DISCUSSION

Testing the mobile phone-based crop leaf shading analyzer inserted with "mlcc" application program in the rice crop field. By taking after the same methodology depicted in Section 4, perform haphazardly pick extra 20 crop leaves to test. And see that the CV values.If the variation occurs between the values when tested these 20 crop samples of same level 1, then the main reason of this variation is the way the user holds the leaf or the distance between the camera and the sample. Although there is a big difference between the CV values but it doesn't affect the range prescribed by the developer because it lies in the same range.

By following the user manual of the LCC for the fix time measurement procedure, the leaf color level 3 is prescribed as a critical level. It the color level is less than 3, the crop needs more N fertilizers. Similarly, if shade is greater than 3 no need of more N fertilizers. This suggestion shows that if "mlcc" application project is analyzing the crop leaf having the genuine shading level of 3, the measure of N composite is some of the time connected more than what is prescribed. In the practical scenario, because there are uncountable crop leaves in field and the leaf color level of the crop in this large area may vary from 1 to 6, sampling more crop leaves in the field and averaging the measured CV values help improvethe overall accuracy. Also, the users ought to truly take after procedure including the season of estimation, the choice of the completely extendedcrop leaf, the position of the crop leaf whileclicking and the distance from the crop leaf to the cell phone's camera.

VI. CONCLUSION

Here propose and appear for the first time how cell phones, for example, a mobile phone can be worked as a shading analyzer for estimating the shade of rice crop leaf. Specifically, here exhibit a cell phone based crop leaf shading analyzer for nitrogen estimation in the crop field. In this work, a smart mobile phone is installed with android-based application program called "mlcc" for breaking down the shading level of the crop leaf and evaluating the suitable measure of N manure. The key thought depends on course of action of crop leaf in such a manner that it is in the field of perspective of the cell phone's camera.

VII. ACKNOWLEDGEMENT

Authors would like to thank to Soil and Water department, Punjab agricultural university, Ludhiana for giving 6-level LCCs utilized as a part of this work.

VIII. REFERENCES

[1] Houshmandfar A and Kimaro A (2011) Calibrating the leaf color chart for rice nitrogen management in Northern Iran. African *J Agric Res* **6:** 2627-33.

[2] Islam M S, Bhuiya M S U and Rahman H (2009) Evaluation of SPAD and LCC Based Nitrogen Management in rice. *Bangladesh J Agril Res***34**(4): 661-72.

[3] Kaur G, Din S and Brar A S (2014) Design and Development of Software for the Implementation of Image Processing Approach for Leaf Area Measurement. *Int J Comp Sci InfoTech* **5**(3): 4793-97.

[4] Kaur S and Singh D (2015) Geometric Feature Extraction of Selected Rice Grains using Image Processing Techniques. *Int J Comp Appl***124**(8): 41-46.

[5] Pandurng J A and Lomte S S (2015) Digital Image Processing Applications in Agriculture: A Survey. *Int J Adv Res Comp Sci Software Engg***5**(3): 622-24.

[6] Tewari V K, Arudra A K, Kumar S P, Pandey V and Chandel N S (2013) Estimation of plant nitrogen content using digital image processing pp.15.