ISSN (Print) : 0974-6846
Indian Journal of Science and Technology, Vol 9(47), DOI: 10.17485/ijst/2016/v9i47/101598, December 2016 ISSN (Online) : 0974-5645

Mobile aRCee Checker an Application of Rice and Corn Checker for Nutrient Deficiency through Leaf Coloration

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Abstract

Objectives: This paper aims to develop an Android Based Application for Diagnosing Rice and Corn Nutrient Deficiency through Leaf and Pattern Recognition. An application designed to quantify Nitrogen, Potassium and Phosphorus deficiency in Rice and Corn crops through the image processing of their leaves. The application also provides farmers the ability to track the test results from multiple farm land. **Methods/Statistical analysis:** The research methods used in this paper are designing and developing. It designs a mobile application that can diagnose rice and corn nutrient deficiency through leaf color and pattern recognition. Moreover, they also developed an application that could calculate the amount of fertilizer needed in rice and corn nutrient deficiency. **Findings:** The results show that the application improved the process of diagnosing rice and corn nutrient deficiency. Thus, the survey result have positive feedback from the respondents. With this, it can calculate the accurate nutrient deficiency of rice and corn. It gives results and suggestions immediately that is directed to rice and corn crops. It is also capable of tracking the tests in a visual graph. **Application/Improvements:** The study is developed in order to address the problems in diagnosing rice and corn nutrient deficiency namely the inaccurate reading, the sampled leaf must be in a controlled light module, time consuming, destructive since the leaf samples are extracted and may take a week for the results and not suitable for determining nitrogen in small area.

Keywords: Leaf Checker, Leaf Color Chart, Mobile Application, Pattern Recognition, Rice and Corn Deficiency, Soil Fertility

1. Introduction

1.1 Background and Rationale

Traditional approaches and practices in detecting and identifying leaves coloration is by naked eye observation of human experts of the field. Experts continuously monitor the results of the observation that resulted to expensive fee especially in the huge farm land area. In addition, experts are few and farmers may have spent much in order to find an expert in detecting and identifying the leaves deficiency through leaves coloration[1].

Leaves coloration is one of the aspects to determine the deficiency. Capturing images of the leaves using mobile camera in detecting and identifying the deficiency can benefit farmers especially with large field of crops. It lessens their expenses and can have an automatic results. Monitoring by tracking the result is easy by logging into the mobile application and it displays result immediately[2].

Captured images are used for processing the application in various areas. Leaves coloration can be detected through various processing by the used of mobile application where captured images serves as an input for detection. It then analyze to identify the deficiency of leaves and can displayed automatic results[3].

Image processing has been proven as an effective tool in the field of agriculture. Some sector in agriculture have many parameters where image processing is a tool that is best suited for analyzing the leaves deficiency. It can be of

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great help by farmers since most of them nowadays have owned smart phones around the globe. With the advent of this technology the results are available to farmers, it can lessen their expenditures and can track and monitor the results.

Further study conducted that image processing is a technology to detect and identify plant diseases. This study eliminates the traditional approaches that resulted to human errors. It helps farmers to monitor and make decisions immediately based on the given results by the application which leads to reduce cost of experts and can help environmental pollution[4].

Pattern recognition enables the user to know the desired result of an image by a digital camera. Pattern is a solution to get into the nearest one from the original. The camera serves as an eye while the algorithm for pattern recognition is the brain that enables to identify the pattern.

Mobile Image Processing (MIP) have some processes that includes modifying, classifying, analyzing and interpreting the images captured via mobile phones. It has the ability to auto-correct the images into its nearest as what the original image looks like. It is capable in converting to its digital form[5].

This study aims to develop an Android Based Application for Diagnosing Rice and Corn Nutrient Deficiency through Leaf and Pattern Recognition. An application designed to quantify Nitrogen, Potassium and Phosphorus deficiency in Rice and Corn crops through the image processing of their leaves. The application also provides farmers the ability to track the test results from multiple farm land.

2. Methodology

2.1 Mobile Application Life Cycle of Rice and Corn

Figure 1 shows the process for the mobile application development. The development stage starts with the identifying and determining the different effects of nutrient deficiencies of rice and corn leaves, specifically on Nitrogen, Potassium and Phosphorus. The Researcher uses the Leaf Color Chart (LCC) as a guide for determining the level of nitrogen deficiency for the crops.

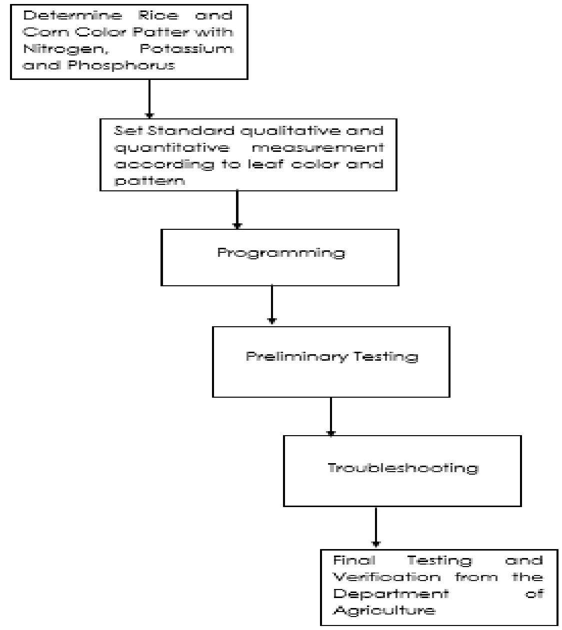

Figure 1. Mobile application development.

Second, the researcher uses the information gathered from the Department of Agriculture to determine the effects of Nitrogen, Potassium and Phosphorus deficiency of corn. Discoloration of some regions of the corn's leaf sign of nutrient deficiency.

Third, is the programming phase, using the different tools for developing a mobile Android Application and an actual mobile device for simulation.

The preliminary testing and troubleshooting are the steps needed to eliminate the erroneous process that is encountered by the application. These erroneous processes are database and image processing errors which lead to the inaccurate results.

Lastly, testing and verification is the last and final stage of the development of the mobile application. In this step, actual testing of the crop leaf is done by the Department of Agriculture Region 10 – Crops Division. This actual testing is to check the usability and functionality of the mobile application.

2.2 System Model

Figure 2 shows the process of the system model of the mobile android application. The diagram comprises of crop samples which represents the rice and corn crops. The user should fill up the crop's information in order to activate the farm before capturing rice and corn leaf. The crop's information is saved to the database for future reference for the result of tracking.

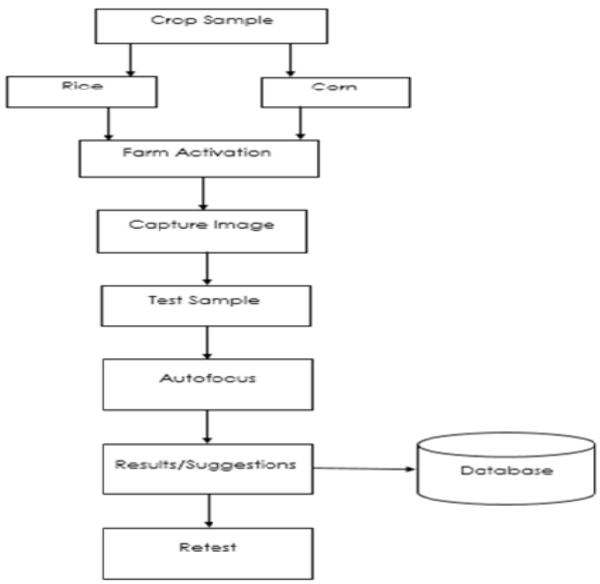

Figure 2. System model.

The test sample can be done if the crop is already activated. During the test, the camera of the developed mobile android application is set to autofocus. It captures three times of every leaf sample.

After the process is done, the nutrient deficiency status of the crop's leaf through leaf color and pattern recognition is determined. For the rice crop, the basis of the leaf color and pattern recognition is the LCC. LCC level and suggested fertilizer is shown in the result page. If the user is not satisfied with the result, he/she can redo the retest; otherwise the result of the crop's leaf captured is automatically saved to database.

2.3 Development of the Mobile Application

In order to realize the application, the researchers used some technologies during development of the application.

2.3.1 Identification of the Software and Hardware for Android-Based Application for Diagnosing Rice and Corn Nutrient Deficiency through Leaf Color and Pattern Recognition

Figure 3 shows the algorithm of for capturing the leaf image. The image process requires the extraction of corn leaf image from the background. The process starts with storing the pixels in an array, second, collect the non-white, non-gray and non-black. Third, create the new image using the collected pixels and with the dimensions of the original image. Lastly, save to the internal storage.

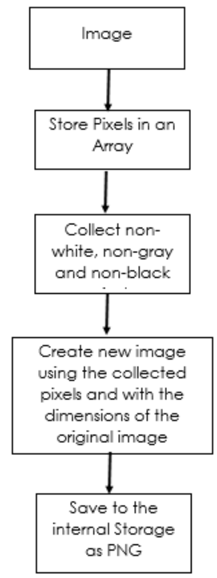

Figure 3. Algorithm for capturing image of the corn leaf.

Figure 4 shows the algorithm for diagnosing the Nitrogen, Phosphorus, and Potassium deficiency in corn leaf.

```
public class getAverageColor {

    int AColors = 0;
    int greenColors = 0;
    int pixelCount = 0;
    int A;
    int green;
   public getAverageColor(Bitmap bitmap){
        for (int y = 0; y < bitmap.getHeight(); y++)
        {
            for (int x = 0; x < bitmap.getWidth(); x++)
            {
                int c = bitmap.getPixel(x, y);
                pixelCount++;
                greenColors += Color.green(c);
                AColors+= Color.alpha(c);
            }
        }
        // calculate average of bitmap r,g,b values
         green = (greenColors/pixelCount);
         A = (AColors/pixelCount);
    }
    public int getGreen() { return green; }
    public int getA() { return A; }
}
```

Figure 4. Source code for getting the average color of region interest of rice image.

Figure 5 shows the algorithm for detecting the rice leaf Nitrogen deficiency.

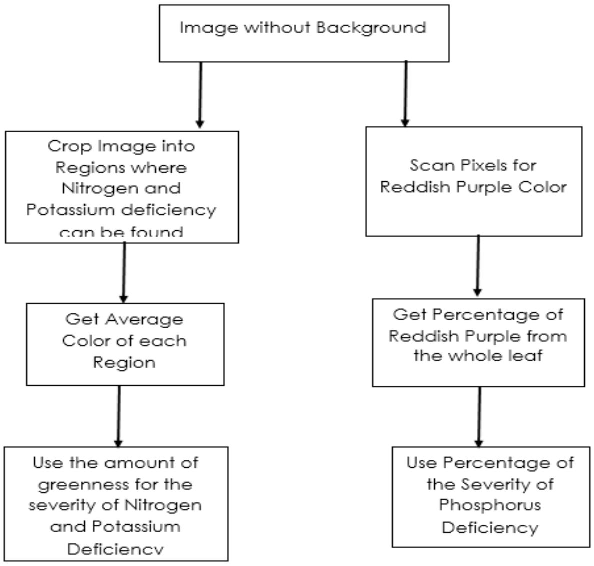

Figure 5. Algorithm for diagnosing nitrogen, potassium and phosphorus deficiency of corn.

Figure 6 shows Algorithm for diagnosing Nitrogen deficiency for rice

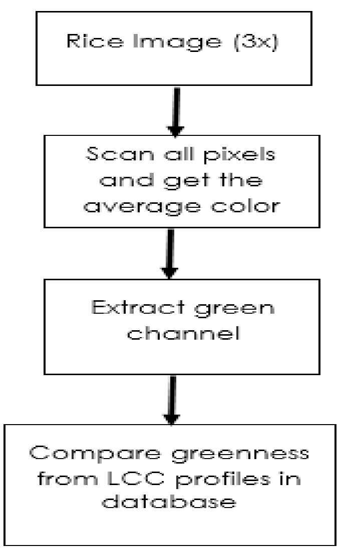

Figure 6. Algorithm for diagnosing nitrogen deficiency for rice.

2.4 Evaluation of the System

In order to evaluate the functionality and usability of the application, the researchers conducted a field testing, to capture rice leaf sample. The researchers demonstrate to the respondents to select 5 samples of rice leaf randomly in a zigzag form of a plot of a rice field. On other hand, in the testing of corn leaf samples, the researchers demonstrate to capture only the older leaves of the corn.

3. Results and Discussions

3.1 Design a Mobile Application for Diagnosing Rice and Corn Nutrient Deficiency

The researchers design a mobile application that can diagnose rice and corn nutrient deficiency through leaf color and pattern recognition. Moreover, they also developed an application that could calculate the amount of fertilizer needed in rice and corn nutrient deficiency.

3.2 Develop a Mobile Application

3.2.1 Prototype

Figure 7 shows the actual process of capturing the leaf image. The red rectangle label in the center of the camera is the area which the rice leaf must fill. The test result view shows the leaf's LCC level. It also shows the transplanted and directly seeded rice fertilizer recommendation.

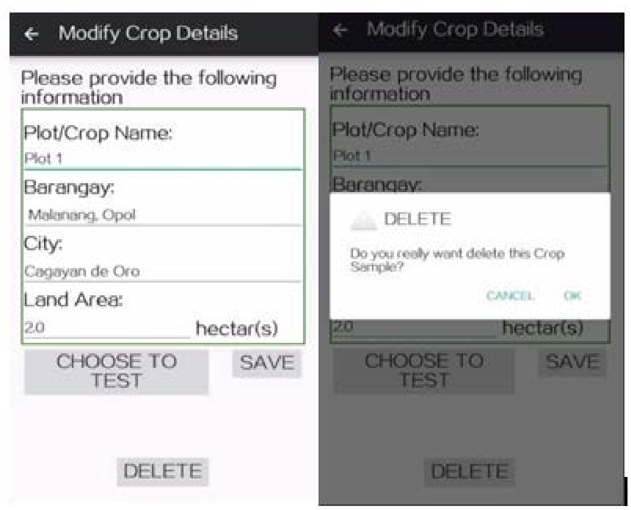

Figure 7. The screenshot in modifying crop sample information.

Figure 8 shows the actual process of capturing the corn leaf image. The red rectangle label set the corn leaf top, bottom, center, left and right in order to get the average color of the corn leaf sample. After capturing the corn leaf sample, it give results of Corn Nitrogen, Potassium and Phosphorus nutrient deficiency severity. This result is based on the leaf color and pattern recognition.

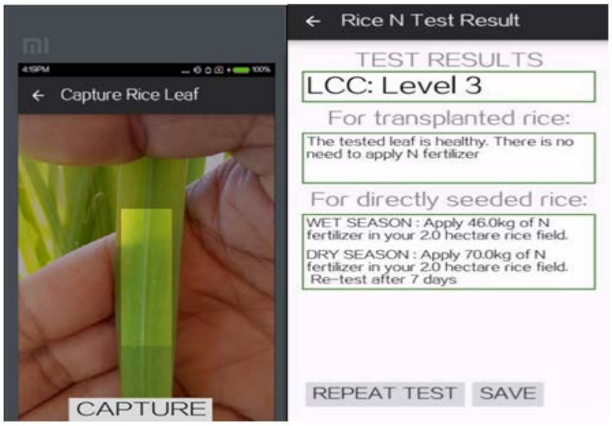

Figure 8. Screenshot of rice leaf nitrogen deficiency diagnosis process and result view.

Figure 9 Screenshot of Corn Leaf Nitrogen, Potassium and Phosphorus Diagnosis Process and Result View. Nitrogen deficiency causes pale, yellowish-green corn plants with spindly stalks. Apply appropriate fertilizer N application and Analyze manure for N content [7]. The potassium deficiency occurs first on lower leaves and it may progress to upper leaves it has yellow and brown coloration of leaf margins. The Remedies is applied appropriate fertilizer K rate. The phosphorus deficiency has purple coloration of lower leaves and it visible usually on young corn. Apply fertilizer P as a 'starter' application.

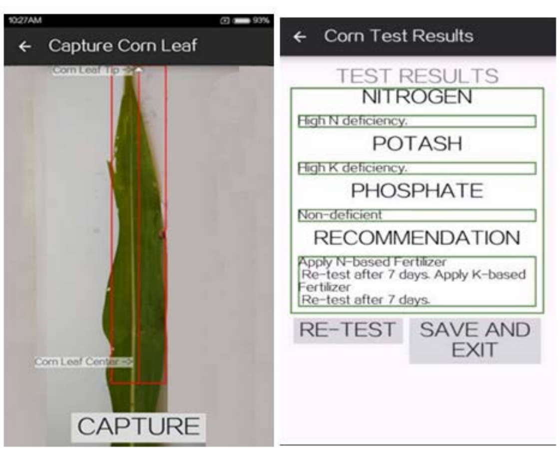

Figure 9. Screenshot of corn leaf nitrogen, potassium and phosphorus diagnosis process and result view.

Figure 10 shows reports of the crops being test. The visual graph indicates the level of the crops deficiency.

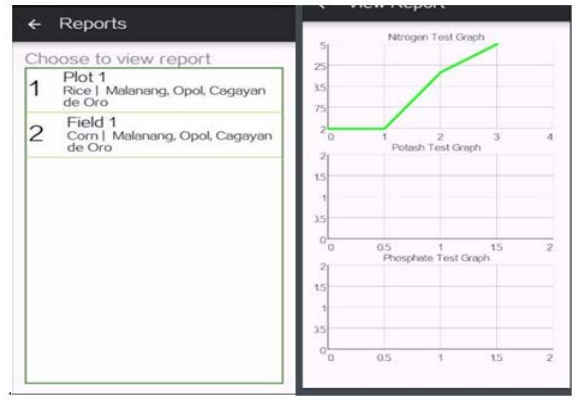

Figure 10. Screenshot of reports view.

3.3 Testing

The researchers conducted a test suitable for the problems stated namely; inaccurate reading, time consuming, destructive, expensive, and not suitable for determining nitrogen in small area. First test is the demonstration of the application to the respondents regarding functionalities. This contains the functionalities of diagnosing the rice and corn nutrient deficiency application.

3.3.1 Survey Questionnaire Results

Table 1. shows the list of functionalities that the researcher's achieved. The application achieves the basic functionalities such as; it can calculate accurate reading of crop's nutrient deficiency. The application can also give result immediately, non-destructive for rice and corn crops since the leaf sample is done in field and determine deficiency in small area.

3.4 Testing and Evaluation of the Application

3.4.4 System Usability Scale

The researchers use the SUS because it has been proven to be a valuable evaluation tool, being robust and reliable. It correlates well with other subjective measures of usability. The SU scale is generally used after the respondent has an opportunity to use the system being evaluated. With 20 respondents, every respondents are asked to use the application first and later evaluate with corresponding questions to test the System's usability.

Table 1. Functionality questionnaire

Question	Strongly Agree (1)	Agree (2)	Neither Agree nor Disagree (3)	Strongly Disagree (4)	Disagree (1)
Does the Application can calculate reading of crop's nitrogen for rice and corn, potassium for corn and phosphorous for corn?					
Does the application gives the result immediately?					
Does the application provides accurate amount of fertilizer to be applied if the crop is nutrient deficient?					
Does the application provides the same result using different android devices?					
Is the application suitable for determining nitrogen in small areas?					

Table 2. shows that the respondents have a positive feedback of the application in terms of its usability. An over-all score was computed by adding up the scores and divided it to number of questions listed in the questionnaire.

Table 2. System usability scale evaluation

Question	Average
I think I would like to use this application frequently	4.25
I found this application unnecessary complex	1.2
I thought this application was easy to use	4.05
I think I would need assistance to be able to use this application	1.15
I found the various functions in this application were well integrated	4.1
I thought there was too much inconsistency in this application	1.1
I would imagine that most people would learn to use this application quickly.	3.95
I found this mobile application very cumbersome/awkward to use.	1.25
I felt very confident using this application	4.1
I needed to learn a lot of thing before I could get going to this application.	1.1

4. Conclusion

This paper was developed in order to address the problems in diagnosing rice and corn nutrient deficiency namely the inaccurate reading, the sampled leaf must be in a controlled light module, time consuming, destructive since the leaf samples are extracted and may take a week for the results and not suitable for determining nitrogen in small area. The results show that the application improved the process of diagnosing rice and corn nutrient deficiency. Thus, the survey result have positive feedback from the respondents. With this, it can calculate the accurate nutrient deficiency of rice and corn. It gives results and suggestions immediately that is directed to rice and corn crops. It is also capable of tracking the tests in a visual graph.

5. References

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