**Android-Based Image Processing Application to Estimate Rice Crop Nitrogen**

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**Chapter 1**

**Introduction**

One primary cause of high production cost in rice farming is the fertilizer. Farmers operate their farms in the traditional way that applies fertilizer not based on plant condition but on a predetermined date upon seeding. This result to either over application or under application of fertilizer since rice growth is not uniform in every area. Both cases lead to rice deficiency resulting to a lower yield. Present agricultural technology researches discourage the use of traditional farming and advocate precision farming. Precision farming is described as that the production inputs (seed, fertilizer, chemicals, etc) should be applied only at the time that are needed for the most economic production to obtain the highest output (Gholizadeh et al., 2009).

Methods of proper fertilizer applications have been developed. One of the most effective means to determine when to apply fertilizer and on what amount is through the Leaf Color Chart (LCC). The LCC is used to assess the plant Nitrogen (N) status. It is an inexpensive and easy-to use tool consisting of four color shades from yellowish green (window no. 2) to dark green (window no. 5). The color strips are fabricated with veins resembling those of rice leaves (irri.org). The assessment will depend on the greenness of the leaf matched to the LCC window. Each window defines a level of N status. Several limitations on the usage, however, are posed by the LCC. The color matching is relative to the person’s color perception, so it is recommended that same person should do the matching. The use of LCC is also limited to only some period of a day due to the effect of sunlight to the color.

This project aims to develop a mobile application that automates the LCC to eliminate its limitations. The application adopts the functionalities and guidelines of the LCC. It can classify a leaf sample to the window it matches. The standard values for matching are set according to the LCC standard. A controlled light module is used to eliminate the color variation imposed by sunlight. The fertilizer recommendation is based on the window specification of the LCC. Database system provides a continuous monitoring on rice status since it stores the readings on previous samples. The image acquisition device that is used to take the sample leaf images is the built-in camera of the Tablet PC. It is necessary that the samples be less prone to noise for accurate results; thus, filtering methods are applied as necessary.

**Statement of the Problem**

Fertilizer must be applied only when necessary and must be based on the crop’s nutrient status. However, most farmers rely on the age (days after transplanting) of rice and not on its condition (Alam et al. 2005). This, consequently, caused inefficiency levels of fertilizer in terms of growth, development, and yield. Moreover, there are farmers applying fertilizer even if the crop does not need it. As a result, there is an insignificant addition to the production cost and undesired effects on the growth of rice.

Overuse of synthetic nitrogen fertilizer has become widespread resulting in severe environmental problems. If the excessive application of nitrogen fertilizer is not brought under control, the environment will continue to deteriorate.

The Leaf Color Chart (LCC) is a tool to rapidly assess leaf N status and thereby guide the application of fertilizer N to maintain optimal leaf N content. This is what motivates the researchers to develop a mobile application for fertilizer management and crop monitoring that aims to enable the farmer to check when it is necessary to apply fertilizer by means of leaf image processing.

**Objectives of the Study**

The study’s general objective is to develop a mobile application for rice leaf analysis based on the image processing capability of android OS Tablet PCs. The study’s specific objectives are:

* To develop an Android application that can determine the level of Nitrogen deficiency of rice through image processing
* To incorporate a database system on the Android application to provide a continuous monitoring of the crop’s N status

**Significance of the Study**

The main beneficiaries of this project are the farmers and the rice consumers. It is intended to make fertilizer management more precise and reliable. By making the farmers’ analysis of their rice quantitative by comparing previous and current readings, it is hoped that they will achieve maximum yield; thus, increasing the rice supply to match the increasing demand for it. This study also aims to minimize the environmental pollution due to excessive application of fertilizer.

Database is provided to give a comparative statistic based on the previous samples so that farmers will have a monitoring system regarding the growth of rice periodically.

**Scope and Limitation of the Study**

This study is delimited to the following:

* The guidelines and fertilizer recommendations set by the LCC are adopted
* The nutrient to be assessed is nitrogen since it is the primary element that contributes to the growth of rice.
* The leaf to be sampled must be in a controlled light module.
* This program uses tools and will rely on Java Environment.
* The camera of the Tablet PC is used as the image acquisition device.

**Definition of Terms**

**Android.** Android is a mobile operating system that is based on the modified version of Linux. It is owned by Google after it was bought in 2005 from Android, Inc.

**Fertilizer.** A fertilizer is any material of natural or synthetic origin that is applied to soils or to plant tissues to supply one or more plant nutrients essential to the growth of plants.

**Nitrogen.** Nitrogen is a common normally colorless, odorless, tasteless and mostly diatomic non-metal gas. It has five electrons in its outer shell, so it is trivalent in most compounds.

**Image processing.** Digital image processing is performed with a computer to manipulate information within an image to make it useful.

**Theoretical/Conceptual Framework**

System Trigger

OUTPUT

(assessment on rice nutrient status)

Image Acquisition

Image Processing

**System Trigger:** A GUI (Graphical User Interface) represents the information and actions available to a user through graphical icons and visual indicators such as secondary notation, as opposed to text-based interfaces, typed command labels or text navigation. The actions are usually performed through direct manipulation of the graphical elements by providing menus to manually access the program.

**Image Acquisition**: The first stage of any vision system is the image acquisition stage wherein the images to be acquired are series of pictures using the Android based tablet, within certain conditions. After the image has been obtained, various methods of processing can be applied to the image to perform many different vision tasks.

**Image Processing:** In image processing and photography, a color histogram is a representation of the distribution of colors in an image. For digital images, a color histogram represents the number of pixels that have colors in each of a fixed list of color ranges, which span the image's color space, the set of all possible colors. The color histogram of the sample images will be correlated to the standard database interrelated to LCC (Leaf Color Chart) diagnostic tool.

Data Comparison (Image Matching

**Data Comparison:** The greenness value of each sampled leaf is obtained by the application and is compared to the standard greenness values for each Leaf Color Chart window saved in the application.

**Output:** The output is a presentation of the processed data gathered from the series of random snap shots. The output presents the needed nitrogen, if there is any and on what amount to apply, to compensate the deficiencies of the rice.

**Chapter 2**

**REVIEW OF RELATED LITERATURE**

This chapter provides the literatures and studies related to the proposed project.

**RELATED LITERATURE**

**FOREIGN**

Image processing is used for the detection of plant diseases. Disease detection involves the steps like image acquisition, image pre-processing, image segmentation, feature extraction and classification **(Khirade.et. al, 2015)**.

Using image processing techniques to classify diseases & quickly diagnosis can be carried out as per disease. This approach will enhance productivity of crops. It includes several steps viz. image acquisition, image pre-processing, segmentation, features extraction and neural network-based classification **(Mainkar.et.al,2015)**

Image Processing is one of the core application of Image processing is one of the most growing research area that is having its participation in different application areas including the biometric system, biomedical system, etc. One of such application area is the agricultural industry. In this application area, image processing is being utilizing in different ways to identify the crop, plant, leaves, flower, fruits etc. as well as to identify the disease **(Rekha Chahar.et.al,2015)**

In agriculture sector, the advice of subject matter specialists is always needed to solve most of the field problems. It requires more time, costlier and is unaffordable. Due to the higher success ratio in other sectors, agriculture sector has initiated to work in combination with the innovative information technology using techniques like image processing, computer vision and machine vision which could mimic the decisions of subject matter specialist. These techniques produce an output for the input image acquired through any of the imaging technique. The results are informative and supportive for farmers, agro based industries and marketers **(D. Surya prabha.et.al,2014).**

Image processing on mobile phones is a new field with many challenges due to limited hardware and connectivity. Phones with cameras, powerful CPUs, and memory storage devices are becoming increasingly common. The need for benchmarking basic image processing routines such as: addition, convolution, thresholding and edge detection is important for comparison of systems. With this information, developers and researchers can design complex computer vision and image processing applications while being aware of the current state of the art limitations and bottlenecks on mobile phones. **(Wells, 2014).**

**Local**

The techniques of image processing are extensively applied to agricultural science, and it provides maximum protection to crops, which can ultimately lead to better crop management and production. Monitoring of pest’s infestation relies on manpower, however automatic monitoring has been advancing to minimize human efforts and errors **(J. Miranda.et.al,2014).**

Computer vision (or machine vision) and image processing are considered to be new and emerging technologies which found the applications in industry, medicine, military and others. The potential is so vast and promising that their use in agriculture must be explored and developed. Since computers and many electronic gadgets are now readily available, it is not as difficult as before to implement projects and investigate creative possibilities that would transform the conventional way of doing things to a possibly more updated method in keeping with the trends in almost all facets of the scientific world **(Bato, P.M*.*.et.al,2014).**

Plant phenotyping is a vital process that helps farmers and researchers assess the growth, health, and development of a plant. In the Philippines, phenotyping is done manually, with each plant specimen measured and assessed individually, but this process is laborious, time-consuming, and prone to human error. Automated phenotyping systems have attempted to address this problem using cameras and image processing, but these systems are proprietary and designed for other plants. To alleviate this problem, the research aims to develop a high throughput rice phenotyping system that automates the identification of plant greenness and plant biomass of C4 Rice **(RJ Buzon.et.al,2014).**

Image processing was incorporated to eliminate the Subjectiveness of manual inspection of diseases in rice plant and accurately identify the three common diseases to Philippine's farmlands: (1) Bacterial leaf blight, (2) Brown spot, and (3) Rice blast **(JW Orillo.et.al,2014).**

**Chapter 3**

**RESEARCH DESIGN AND METHODOLOGY**

This chapter presents the research design, research method and procedures employed in the completion of this study.

The waterfall model is a [design](https://en.wikipedia.org/wiki/Design) process that is [sequential](https://en.wikipedia.org/wiki/Sequence), it is used in [software development processes](https://en.wikipedia.org/wiki/Software_development_process). The progress is seen as flowing steadily downwards through the phases of analysis, design, implementation, testing, deployment and maintenance.



**Figure 1.2** Waterfall Model

Sequential phases in Waterfall model are:

**Requirement Analysis:** All possible needs/requirements of the system for developing are captured in this phase.

**System Design:** In this phase the requirement specifications from first phase are studied in this phase and system design is prepared and it helps in specifying hardware and system requirements and helps in defining the whole system architecture.

**Implementation:** From system design inputs, the system is developed first in small programs that are called units in which are integrated in the next phase. Every unit is developed and tested its functionality which is called as Unit Testing.

**Testing:** All developed units in the implementation phase are integrated into a system after the testing of each unit. In this phase the entire system is tested for any faults and failures.

**Deployment of system:** When the functional and non-functional testing is done, the product will be deployed to the customer environment.

**Maintenance:** In this phase, there are unavoidable issues which come up in the client environment and to fix those issues patches are released or enhance the product some better versions to satisfy the client environment.

**Research Design**

The project construction began with the research on methods determining rice nitrogen content based on leaf color. The researchers came across the Leaf Color Chart (LCC), the existing tool for nitrogen detection based on rice leaf. The problems and limitations such as inaccuracy and user-bias were identified as the main issues resolved by this project. The feasibility of implementing and improving LCC through an image processing system was first verified. Consultations were done for possible implementation of the project. After which, the researchers decided to implement the project using a Tablet PC which is equipped with image processing capabilities.

**Methodology**

The Android-Based Image Processing Application to Estimate Rice Crop Nitrogen uses the waterfall model. Because this method can provide support for carrying out the deliverance. Waterfall model proposed an organized, sequential approach into the system development that begins at the system level progresses through the analysis, design, implementation, testing, deployment and its maintenance.

**Sampling Techniques**

The researchers conducted investigation to be resolved is portability, second is capability to acquire high resolution picture (at least 3 mega pixels) and lastly efficiency to process (1core-dualcore) java program. The specification matches analogously to a Tablet PC which the researchers decided to use. Since Tablet PC’s operating system is Android, it is java-compatible as the programming language to develop the program for implementing the leaf image processing.