https://dx.doi.org/10.22161/ijaers.4.10.7 ISSN: 2349-6495(P) | 2456-1908(O)

Detection of Paddies Reflectance Values to classify their Ages using RGB Photograph Images

Bowo Eko Cahyono, Agung Tjahjo Nugroho, Miftahul Rizkiyani

Physics Department of Jember University, Jember, Indonesia

***Abstract*— *Rice is a very important food in the world, a staple food for more than half of the world's population, especially Asia. People in Asia plant rice crops, more than 90% of the world's rice crops which are grown. In the current technological era the conditions of agricultural crops such as rice can be monitored rapidly from the air. This study aims to classify the age of rice plants based on cartesian coordinate position vectors from the extracted basic, red, green, and blue color spectrum of reflectance. The research was done by taking the image of rice plants based on age classification and Furthermore, the extracted values of each spectrum is normalized and then be plotted on cartesian coordinate The result obtained from this research is the position vector of normalized RGB values be able to differentiate the age classification of rice plant. The each vector position represented a single group of age classification. The three vector units i.e. red, green and blue figure every axis on the 3 dimensional Cartesian coordinates. This research concluded that the 3-dimensional position vector method of cartesian coordinates, can classify the age of rice plants.*

Keywords*— *Cartesian coordinates, Position vector, RGB, Rice.

I. INTRODUCTION

Rice is a very important food crop in the world. It becomes a staple food for more than half of the world's population, especially Asia, in which more than 90% of the world's rice crops are grown and consumed [1]. Although the staple food can be substituted by other foodstuffs, but they cannot easily satisfy people who use to eat rice daily. People say that they do not eat yet when they do not eat rice in a day [2]. As rice crops are very important, monitoring the rice field to know the growth condition is also important. In today's technological era, agricultural crop conditions such as rice can be monitored rapidly from the air. The methods can be observations using camera or sensor which is plat formed on helicopter, aircraft, drone (UAV=Unmanned Aerial Vehicle) and satellite [3].

In principle, detection of crop plant using remote sensing is based on the identification of the reflectance value of the light which strikes the plantation such as rice [4]. The algorithm used can be vary as like as NDVI (Normalized Difference vegetation Index), VIDN (Vegetation Index Differencing), LAI (Leaf of Area Index) and others [5]. Different spectral bands are also applied depend on the purposes and applications of detection. The greenness level detection usually uses red and infrared bands [6], while red, green, and blue (RGB) spectrum bands were used to detect the Phytoplankton abundance [7]. It means that the reflectance of RGB (red, green, and blue) spectrum can identify the existence of object with chlorophyll content.

Similar to Phytoplankton, the leaves of rice crops (paddies) contain also chlorophyll cells which can be sensed by the reflectance values in the RGB spectrum. These values represent the amount of chlorophyll in the leaf. Different chlorophyll content in the leaf leads to the different values of reflectance in the RGB spectrum [8]. The chlorophyll content also indicates the greenness of the leaf [9]. Therefore the leaf with different greenness level will impact to the different reflectance values in the RGB spectrum.

Camera especially digital camera is often used to record the image of the researched object based on the reflected light. The digital image from camera can be extracted into RGB layers and the calculated the reflectance values using computer software such as MATLAB. Moreover, the reflectance values can be analyzed to identify the characteristics of the objects.

Furthermore, we can apply the reflectance values that indicate the chlorophyll content in the leaf to classify the age of paddy. Different age of paddy shows the different amount of chlorophyll [2]. The research to identify the growth stage of paddy through the analysis of reflectance values in the RGB spectrum has not been done. The yielding time can be predicted if we can monitor the age of paddy in the rice farm and also we can calculate the harvesting area. This research is important to support the agricultural data which is useful to know the total

https://dx.doi.org/10.22161/ijaers.4.10.7 ISSN: 2349-6495(P) | 2456-1908(O)

production of paddy in a year based on the production data in the certain harvesting seasons.

II. REVIEW OF LITERATURE

A. Paddy Plantation

Rice plants are very easy to find, especially in rural areas. Paddy fields are filled with rice crops. Rice is a plant belonging to the genus of Oryza L. which includes approximately 25 species, spread over the tropical and subtropics regions, such as Asia, Africa, America and Australia. The current species of paddy is a result of cross-breed of Oryza officianalis and Oryza sativa F. Spontane [10]. The recent cultivated paddies have undergone many changes not only the outer form or morphological, but the physiological aspects also change.

These morphological changes include leaves; the number of leaves becomes more numerous. The leaves dimensions are become longer, bigger and thicker. The other changing are the number of tillers grew, the branch began to form in accordance with the number and development of the seedling, and the branch began to become more. Physiological changes in rice include: the rate of growth of plants to be faster, as well as the rate of growth of seedlings; Seed dormancy becomes shorter [10]. The view of paddy plantation in the field is shown in Fig.1 below.

Fig.1: Paddy plantation in the field [10]

B. Interaction of light and matter

There are two reflection models when light strikes the object i.e. specular reflection and diffuse reflection. The specular reflection occurs at the medium with flat and smooth surface where the reflected rays are all parallel to one another. The other type of reflection is a diffuse reflection, where the reflected rays travel in random directions because the light hits the rough surface. A surface behaves as a smooth surface as long as the surface variations are much smaller than the wavelength of the incident light [11]. Every surface of the object undergoes diffusion and speculative reflection. Most surfaces experience more speculative reflection, but some experience diffuse reflections [12].

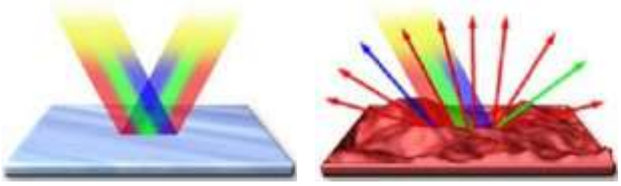

Fig.2: Reflection on the objects (a) specular reflection (b) diffuse reflection [12].

C. RGB Color Model

RGB is a color model consisting of three layers called basic colors that are red, green, and blue. They are combined in forming a wide array of colors. Each basic color, for example red, are composed in 8 bit value range with the smallest value is 0 and the largest value is 255.. The 255 scale option is based on how to reveal the 8 digit binary numbers used by computer machines. In this way, the possible combination colors produced with these three layers are 256 x 256 x 256 or equal to 16,777,216 colors.

In the 3 dimensinal Cartesian coordinate, a type of color can be imagined as a point in 3-dimensional space vector normally used in mathematics. So, a color can be written as a point vector of (0,0,0) until (255,255,255). Each axis in the Cartesian coordinate represents layer Red, Green, and Blue of RGB model..The RGB point of (0,0,0) meant to the values of red=0, green=0, blue=0 or the color of black. Meanwhile the RGB point of (255,255,255) describe the values of red=255, green=255, blue=255 or the color of white. The other colors are represented by various combination values of red, green, and blue with range values from 0 to 255 for each layer [13]. The picture of layer Red (R), green (G), and blue (B) in the 3 dimensional Cartesian coordinate is shown in Fig.3.

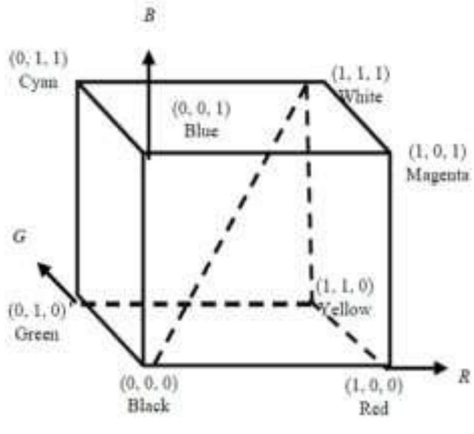

Fig.3: RGB color model in the three dimensions of cartesian coordinates [13]

D. Normalization

The magnitude of reflectance as a characteristic of an object is difficult to measure by the photograph images. But we can choose the normalization values to represent the reflectance values. We can assume that white paper will reflect all light which strike it. Thus we can indicate the reflectance value of the object in the RGB spectrum by comparing the digital number of the object and the digital number of white paper in term the object and white paper are shoot in the same time and place. The normalization values of the spectrum can be calculated by:

$$d_r = \left(1 - \left(\frac{K_r - D_r}{K_r}\right)\right)$$

$$d_g = \left(1 - \left(\frac{K_g - D_g}{K_g}\right)\right)$$

$$d_b = \left(1 - \left(\frac{K_b - D_b}{K_b}\right)\right)$$

Where:

d_r, d_g, d_b = normalized digital number in red, green, and blue layers

K_r, K_g, K_b = averaged value of digital number of paper in red, green, and blue layers

D_r, D_g, D_b = averaged value of digital number of paddy in red, green, and blue layers

III. RESEARCH METHODS

The data collection was performed by taking pictures of rice plants in the field using digital cameras that is Nikon DSLR D700. The data in this study was collected on 3 age groups of rice plants, each of them consisting of 3 various age classes. The first group is rice aged of 10 days to 30 days with the age classes variation of 10 days, 20 days and 30 days. The second group is rice at age 50 days to 70 days with the variation of age classes 50 days, 60 days and 70 days. The third group is 80 to 100 days of age with variation of 80 days, 90 days and 100 days. So, all the research data are divided into 9 age classes. The number of images which are taken in each age classes are 10 images or we will have 90 images from this data collection process.

All the retrieved images are then cropped into two parts i.e. paddy and white paper. In this case, white paper is used as a reference of ideal object which reflect all incident light. These two cropping images are then extracted into digital number in red, green, and blue layers. This extracting step is applied to all existing images and all values resulted are written in the data table.

The next process is calculating the normalized values of each image in red, green, and blue layers and the results are recorded in the separate table. Based on this data, we can plot the values as a point in the 3 dimensional Cartesian coordinate and therefore we get 90 points which represent every image characteristic for every age classes. Finally the analysis is conducted according to this plot resulted.

IV. RESULTS AND DISCUSSIONS

In this study, each retrieval image is cropped to be two images of rice plant and white paper as shown in Fig.4a and Fig.4b. Those cropping images act as representation of analized paddy and white paper as an ideal white object.


(a)

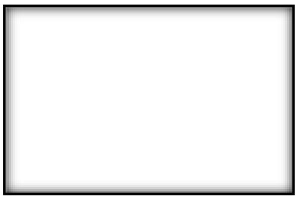
(b)

Fig.4: The cropping images of (a) paddy and (b) paper

Each cropping image is then sliced into RGB layers and from each layer is read the Digital Number (DN) value every pixel and calculate the average value. For example from Fig.4a we get the average value of layer R = 81,203, G = 109,193, B = 31,878 and from Fig.4b we get the average value of layer R = 254,986, G = 254,985, B = 254,990. The same step is done on each photo obtained and the values are written in

Table.*1*. The sample of RGB values in

Table.*1*.refer to the cropping images in Fig.4a and Fig.4b. Based on these data, the normalized values is then calculated so we can draw a point from these values. The normalized red value is drawn in red axis, the green value is drawn in green axis, and also the blue value is drawn in blue axis.

Table.1: RGB values example of cropping image of paddy and white paper

File Name	R value	G value	B value
Paddy	81.203	109.193	31.878
paper	254.986	254.985	254.990

It has been mentioned that the processes of image cropping, extracting the digital number, normalizing, and plotting in 3 dimensional Cartesian coordinate are applied to all captured images. Every normalization value of an image is represented in one point inside the plot frame. All data point are drawn in one plot and the result is shown in Fig.5. The detail of normalized values of all research data are given in the appendix tables. In this figure we can see that there are 9 groups of points as representation of 9 classes of data i.e. 10, 20, 30, 50, 60, 70, 80,90, and 100 days of paddies ages.

https://dx.doi.org/10.22161/ijaers.4.10.7 **ISSN: 2349-6495(P) | 2456-1908(O)**

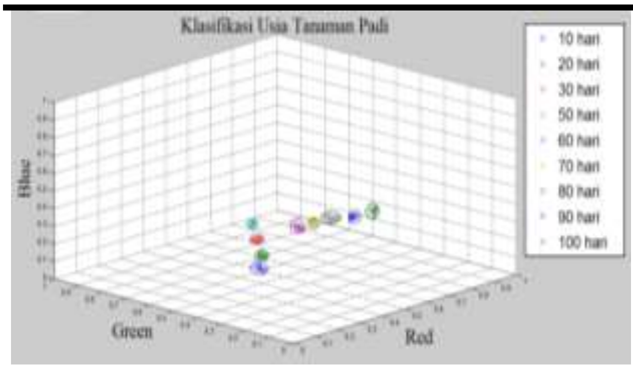

Fig.5: Plotting all normalized data in 3 dimensional Cartesian coordinate

The result of normalization values in the plot illustrates that every age classes of paddies plantation are located in different positions. Every position of classes can be considered as position's vector in the dimension of red, green, and blue (RGB) axis. In the plot we can see that the position's vector is changing following the growth age. However, the trend of changing can be analyzed better when we provide the position's vector in 2 dimensional coordinates as shown in Fig.6 to Fig.8 below.

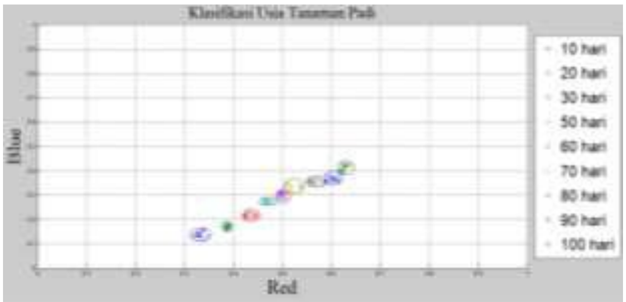

Fig.6: Projection of plotting data in 2 dimensional (red and blue) Cartesian coordinate

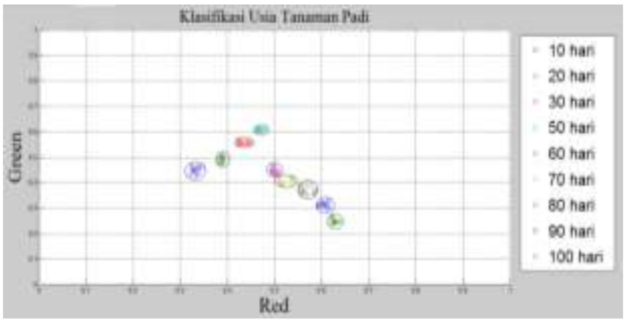

Fig.7: Projection of plotting data in 2 dimensional (red and green) Cartesian coordinate

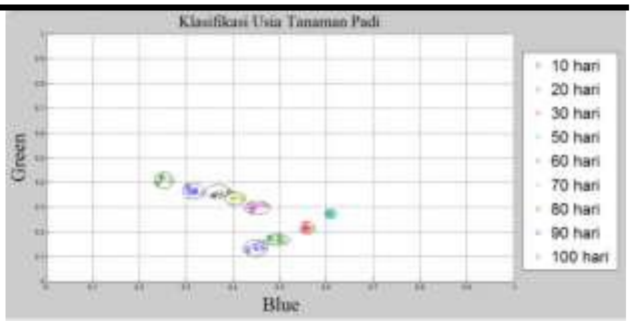

Fig.8: Projection of plotting data in 2 dimensional (green and blue) Cartesian coordinate

The last three pictures show clearly the changing trend of vector of normalized values of paddies reflectance. The values in red and blue axis are consistently increasing along the increasing age of paddy. However the trend of vectors in red and green plane projection shows different pattern. Reflectance in green axis increase from paddies with 10 days to 50 days, but the values decrease from 60 days to 100 days along red axis. The opposite direction of pattern occurs in the green spectrum reflectance along the blue axis. In the green and blue plane projection, the reflectance values in green spectrum decrease in time of increasing age of paddies.

In conclusion we have not get yet the results of position's vector in a single axis of color spectrum to characterize the age of paddies based on their reflectance values. But we must express the position's vector of paddies age in three axis of color spectrum RGB. If the unit vector in the red, green, blue axis are written as $\hat{r}$, $\hat{g}$, and $\hat{b}$ respectively, we get the position's vector of paddies in the age of 10 to 100 days as the mathematical expressions below.

a. $U_{10} = 0{,}331\,\hat{r} + 0{,}448\,\hat{g} + 0{,}137\,\hat{b}$
b. $U_{20} = 0{,}387\,\hat{r} + 0{,}491\,\hat{g} + 0{,}169\,\hat{b}$
c. $U_{30} = 0{,}433\,\hat{r} + 0{,}556\,\hat{g} + 0{,}217\,\hat{b}$
d. $U_{50} = 0{,}469\,\hat{r} + 0{,}607\,\hat{g} + 0{,}273\,\hat{b}$
e. $U_{60} = 0{,}499\,\hat{r} + 0{,}447\,\hat{g} + 0{,}301\,\hat{b}$
f. $U_{70} = 0{,}525\,\hat{r} + 0{,}406\,\hat{g} + 0{,}335\,\hat{b}$
g. $U_{80} = 0{,}568\,\hat{r} + 0{,}369\,\hat{g} + 0{,}355\,\hat{b}$
h. $U_{90} = 0{,}604\,\hat{r} + 0{,}313\,\hat{g} + 0{,}367\,\hat{b}$
i. $U_{100} = 0{,}627\,\hat{r} + 0{,}249\,\hat{g} + 0{,}415\,\hat{b}$

V. CONCLUSION

The age classification of rice plants in 3 age groups, 10-30 days, 50-70 days and 80-100 days, has been successfully performed based on the basic RGB color spectrum with 3-dimensional Cartesian coordinate position's vector method. The vectors represent points of normalized reflectance values of paddy compare to white paper. The images data are retrieved using digital camera Nikon DSLR D700.

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Vectors of paddies reflectance values in each age class place different location or in other words the position's vector of paddies in different classes be be distinguish obviously. The patterns of changing position of data vector are projected into 2 dimensional Cartesian coordinate to make it easy to analyze. The values in red and blue axis are consistently increasing along the increasing age of paddy. Reflectance in green axis increase from paddies with 10 days to 50 days, but the values decrease from 60 days to 100 days along red axis. In the green and blue plane projection, the reflectance values in green spectrum decrease in time of increasing age of paddies.

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