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Productive Plant Evaluation Methods Comparison Based on Digital Images at Tea Plantation Area

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ABSTRACT: In this study, an analysis of methods developed to evaluate productive plants has been carried out. The plants in question are plantation crops or agriculture in the broad area. The evaluation based on aerial photographs obtained from an unmanned aerial vehicle. The evaluation method is done by using image processing to determine the characteristics of plants in aerial photography. Classification of productive and unproductive plants will be analyzed using several feature extraction methods including Histogram, Local Binary Pattern (LBP), Structural Similarity Index (SSIM), Peak signal to noise ratio (PSNR), and mean square error (MSE). The results of this study which are useful method analysis for evaluating productive plants. The result will provide benefits to plantation owners or agricultural land, especially with large areas. This technology will be used to evaluate plantation crops or agriculture using aerial photography so that the evaluation process can be carried out without having to walk around the land that may reach several hectares.

KEYWORDS: Analysis of methods, classification, productive plants, image processing

I. INTRODUCTION

Aerial photograph taken using unmanned aerial vehicle (UAV) can be used for various fields such as for area mapping, to determine the area of buildings, and also to analyze crops in a full field[1]. The area of the plantation which sometimes reaches several hectares will be challenging to analyze, regarding productivity or plant conditions in a short time. Therefore, the role of aerial photography is significant in helping get the data to the analysis process. Aerial photography can cover a large area of the plantation depending on the height of the aircraft when taking pictures. The higher photograph, then broader scope of the area will be, but it will also affect resolution or the level of detail of the plantation area itself [2]. The results of aerial photographs can then be used to evaluate the condition of the plantation. Evaluation results can be used as a basis for further handlings such as prevention and treatment of diseases, or strategies to increase agricultural production. Aerial photos of the tea plantation area can be taken using unmanned aircraft. From these data, it can be done to take features of plants to find out productive plants and non-productive plants. The results of these characteristics can then be classified to produce an evaluation of the condition of the plant in the plantation. Evaluation of aerial photographs can be done with various methods including color and shape analysis [3]. This study will compare several methods of evaluating aerial photography to find out the most appropriate method for evaluating productive plants in aerial photography. The classification of productive plants and unproductive ones was analyzed using several feature extraction methods including Histogram, Local Binary Pattern (LBP), Structural Similarity Index (SSIM), Peak signal to noise ratio (PSNR), and mean square error (MSE) [4].

This research is expected to provide an analysis of the appropriate methods for evaluating productive plants, especially for tea plantations. The problem that became the focus of the settlement in the study was that there was no comparative analysis of the method of evaluating productive plants on plantations based on aerial imagery. Therefore this research is a reference to determine a suitable method for evaluating productive plants, especially in aerial photographs of tea plantations.

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II. RELATED WORK

Research on evaluating productive plants is used to provide an analysis of good plant growth so that it can be used to increase yields on plantations. Some studies related to plant evaluation include the research of Ji-Hua who designed a system for monitoring the development of plantation crops that can be applied globally. The monitoring system consists of two types of systems, namely a real-time monitoring system using sensors that directly monitor the condition of the plant and then store the data on the server. The real-time data is then compared with the previous year's data to be then classified and produce statistical data that has separate levels of development and distribution of the area. The second system is monitoring plant growth processes based on NDVI data which will produce statistics on plant development data. The data is then extracted to produce an eigenvalue value of plant growth. Both of these data are combined and produce a visualization of the evaluation of plant growth scattered in various areas [2].
Evaluation of plants can also be done using image analysis as in the research of Soria-Ruiz in 2007 using image data from the RADARSAT-2 satellite. Images from satellites are equipped with microwave capture data from the observed area to produce sufficient analysis for plant evaluation. The evaluation is done to divide the area that has vegetation with areas without plants. Then from the data, the area of the plantation can be used to separate suitable vegetation from the other area [1].

III. RESEARCH METHOD

The method used for analyzing image data in this study using several methods including:

- Histogram (Grayscale)

A histogram is a method for extracting color data from an image. Data per pixel of the image will be grouped according to the color value from 0 to 255. In the color image, there are four components of the histogram, namely the colors Red, Green, Blue, and Grayscale. Whereas in the grayscale image there is only one component histogram. From the histogram, data can be seen the distribution of colors in an image so that it can be observed if there is a difference in color in the image if the histogram graph value is different [5].

- LBP (Local Binary Pattern)

In the LBP method, the image data will be converted into grayscale images and will then be converted into binary code with a certain threshold. The data will then be divided into pixel blocks and compared to the surrounding area. Thus the LBP value will represent the pattern of an image. This value can be used for comparison between areas in an image [6].

- SSIM (Structural Similarity Index)

The SSIM method is used to check the quality of an image based on its structure [7]. The structure of the image being examined is the pixel structure using the following formula:

$$\mathrm{SSIM}(x,y) = \frac{(2\mu_x\mu_y + c_1)(2\sigma_{xy} + c_2)}{(\mu_x^2 + \mu_y^2 + c_1)(\sigma_x^2 + \sigma_y^2 + c_2)}$$

with:

- μ_x the average of x;
- μ_y the average of y;
- σ_x^2 the variance of x;
- σ_y^2 the variance of y;
- σ_{xy} the covariance of x and y;
- $c_1=(k_1L)^2$, $c_2=(k_2L)^2$ two variables to stabilize the division with weak denominator;
- L the dynamic range of the pixel-values (typically this is $2^{\#bits\ per\ pixel}-1$);
- $k_1=0.01$ and $k_2=0.03$ by default.

The SSIM index satisfies the condition of symmetry: $SSIM(x,y) = SSIM(y,x)$

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- MSE (Mean Squared Error)

The MSE method is a method for calculating the average error of an image by comparing the value of one matrix block to another matrix block using the following formula: [8]

$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

- PSNR (Peak signal to noise ratio)

The PSNR method is also used to determine the quality of an image from a pixel and to use MSE data. The formula for calculating PSNR values is as follows: [4]

$$PSNR = 10\log_{10}(peakval^2/MSE)$$

IV. IMPLEMENTATION

This research is focused on evaluating aerial photographs of an agricultural / plantation area using photos obtained from UAVs. The basic needs of this research are aerial photography of the plantation area to be evaluated. Aerial photography is taken through the UAV system using a camera mounted vertically on the UAV and already integrated with GPS. The camera will take pictures according to the waypoint point. Aerial photographs obtained will be combined to obtain a more extensive area coverage. Examples of data taken by UAVs with aerial photographs can be seen in Figure 1. Aerial photographs obtained from UAVs will then be stitched/combined into one large image which can then be used for the evaluation process.

Figure 1. Stitched photographs of UAV on a plantation

In this study, evaluation of plants will use several extraction methods, the features of which are histogram, LBP (Local Binary Pattern) [6], SSIM (Structural Similarity Index) [4], PSNR (Peak Signal to Noise Ratio) [9], and MSE (Mean Square Error) [8]. Before processing each extraction method, aerial photographic images will be converted into grayscale first because this study is limited only to the grayscale texture analyzed. In picture 2, can see the change of plantation image to grayscale. Images that are already in grayscale form will then be cut into small parts to facilitate

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evaluation. Each section has a size of 100x100 pixels, which is enough to display the texture of plants that can be analyzed. In figure 3 can be seen the image before it is cut and after being cut into a size of 100x100 pixels.

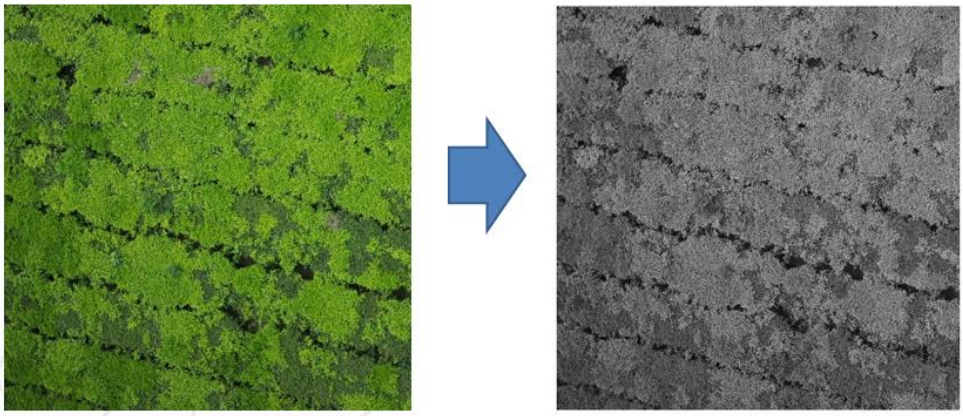

Figure 2. Conversion of images that will be analyzed to grayscale

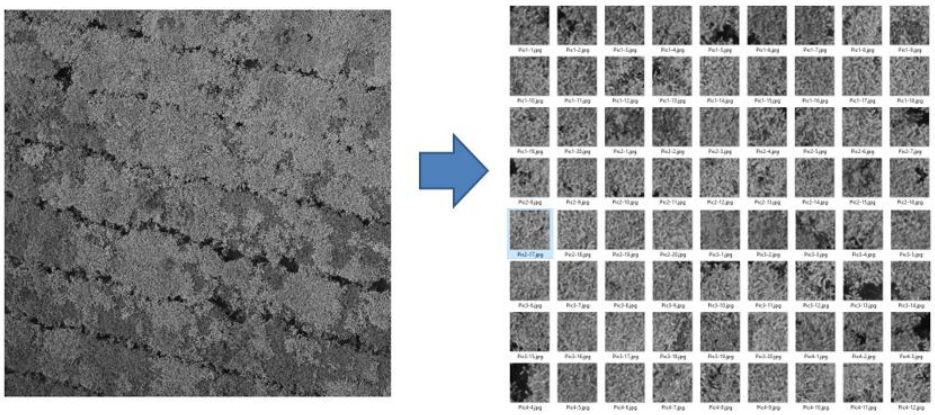

Figure 3. Separation of images to a size of 100x100 pixels

Each block of the image that has been cut will then be compared with the reference image, i.e., blocks of productive plants that have been manually checked in the field. The productive plant blocks can be seen in Figure 4. Perbandignan of each extraction method using the same threshold is then used in the classification of blocks of productive crop images and non-productive plants as shown in Figure 5. The results of this separation are also displayed in the form of whole images so that can be seen the spread of productive and non-productive plants. In figure 6, we can see the distribution of productive and non-productive plants where non-productive plants will be marked with blue blocks.

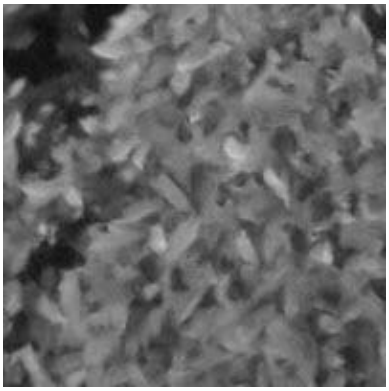

Figure 4. Block of productive tea plants

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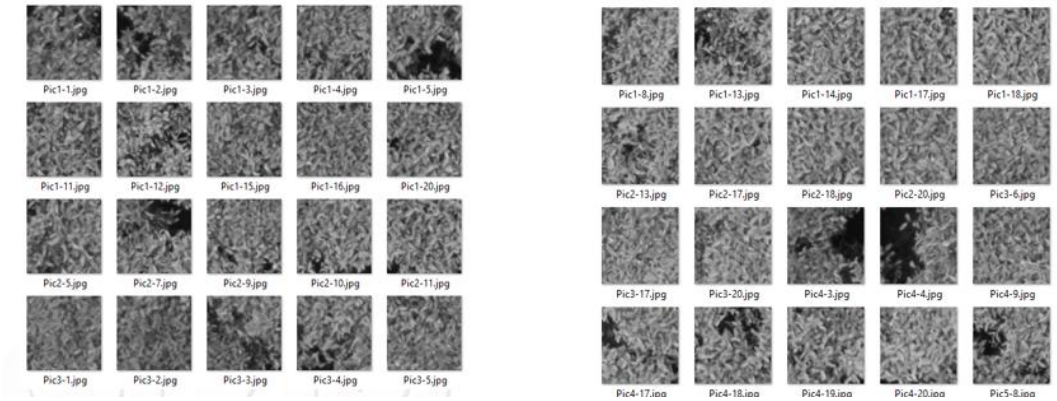
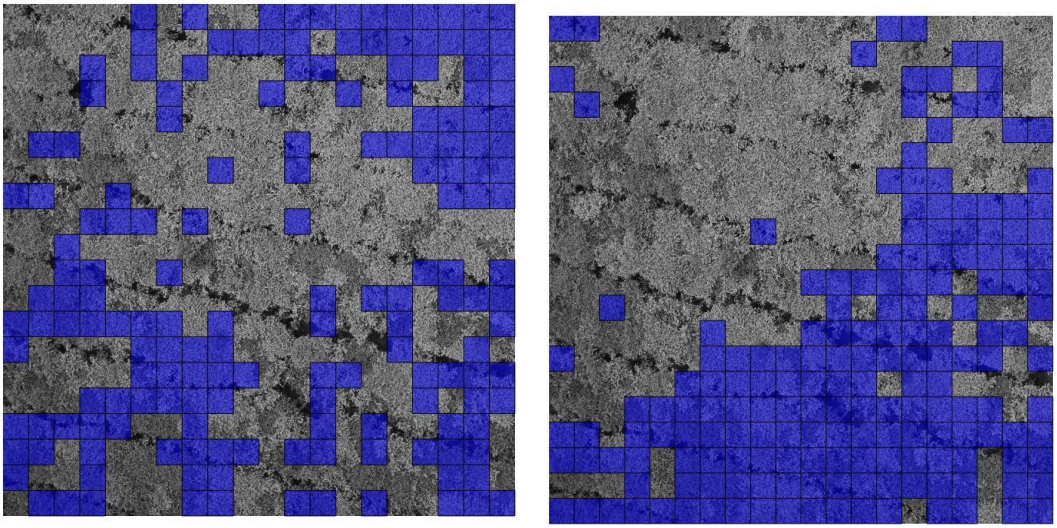
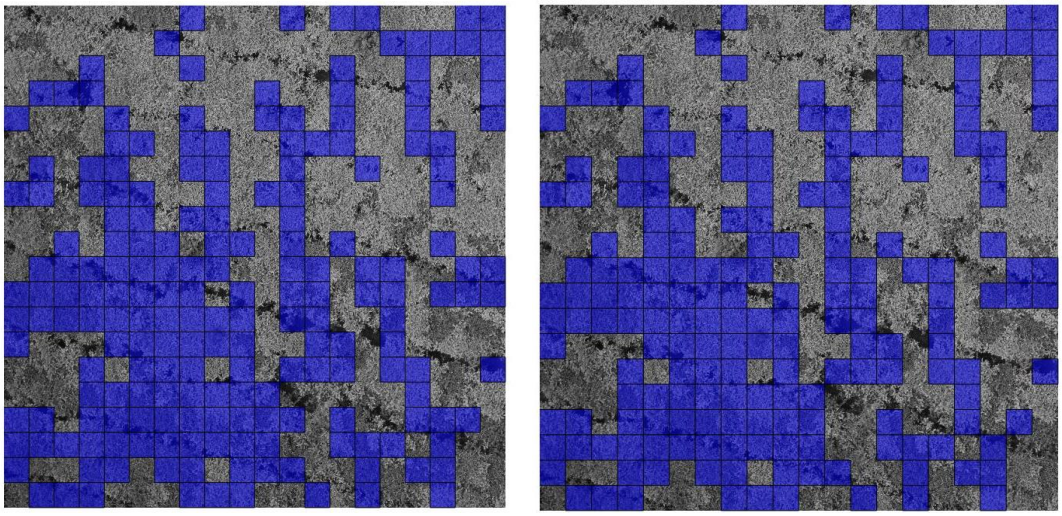


Productive **Non-Productive**

Figure 5. Results of Separation of productive and non-productive plants



Histogram LBP



PSNR MSE

Figure 6. Distribution of productive and non-productive plants

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V. ANALYSIS

The Research that has been carried out so far using several methods for evaluating productive and non-productive plants. From each method used, data on productive plant blocks and non-productive plant blocks are summarized in table 1.

Table 1. Number of productive and non-productive plant blocks for each method

Method	Productive Block	Non-Productive Block
Histogram	234	166
LBP	223	177
SSIM	177	223
PSNR	205	195
MSE	210	190

From the results of the study, it was found that the histogram method produced the most productive blocks with the results of 234 blocks while SSIM produced the least non-productive blocks with 177 block results. From these data, a graph of comparison has been made which can be seen in Figure 7.

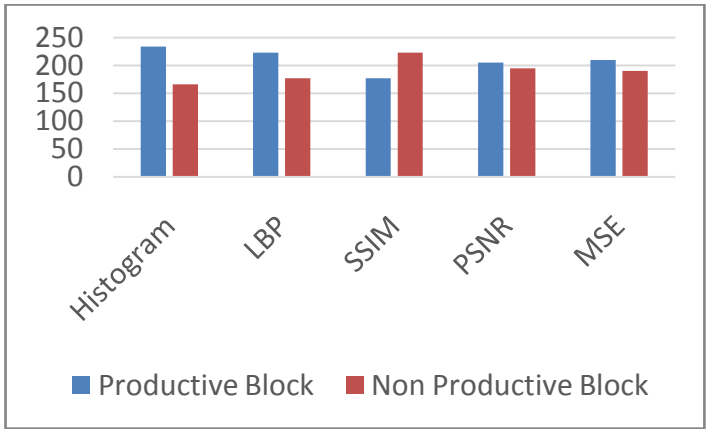

Figure 7. Comparison graph for each method

VI. CONCLUSION

The conclusion based on the research activities and data obtained it can be concluded that from several methods that have been analyzed to evaluate productive plants, the histogram method produces the most productive blocks while the SSIM method produces the fewest blocks. So the histogram method can be used effectively separate between productive and non-productive plant in tea plantation that has more than 50% productive block in the analysis.

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VII. FUTURE WORK

Suggestion for future development as follows:
• Try another plantation area image as input data
• Comparing several samples of productive plant blocks and make cross analysis

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