Clustering green openspace using UAV

By Basuki Rahmat

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Clustering green openspace using UAV (Unmanned Aerial Vehicle) with CNN (Convolutional Neural Network)

[1] Moh Yanni Fikri, [2] Khafid Azzarkhiyah, [3]Muhammad Juan Al Firdaus, [4] Tommy Andreas Winarto, [5] Mat Syai'in, [6] Ryan Yudha Adhitya, [7] Joko Endrasmono, [8] Mohammad Basuki Rahmat, [9] Annas Singgih Setiyoko, [10] Fathulloh, [11] Efrita Arfah Zuliari, [12] Agus Budianto [13] Adi Soeprijanto
([1-7])*Automation Engineering Study Program*
([8-9])*Electrical Engineering Study Program*
([1-10])*Shipbuilding Institute Polytechnic of Surabaya*
([11-12])*Adhi Tama Institute of Techhnology Surabaya*
([13])*Sepuluh Nopember Institute of Techhnology*
Surabaya, Indonesia 60111
Fmoh.yanni@gmail.com

***Abstract*—The latest in unmanned aerial vehicles (UAVs) and associated sensing systems make these increasingly attractive platforms to the remote sensing community. A large number of spatial details contained in these images opens the door for advanced monitoring applications. In this paper, we use this cost-effective and attractive technology for the automatic detection of green open spaces. Given a UAV image of trees acquired, then, we analyze these Convolutional Neural Networks (CNN) points of the prior classifier trained on a set of trees and no trees points. As output, CNN will mark each detected tree by super pixel. Then, in order to capture the shape of each tree, we propose to merge this pixel-level segmentation with a method based active contour on the Color threshold. Finally, we further analyze the texture of regions with pixel-level segmentation and use summing pixel to distinguish trees from other vegetation. Experimental results obtained in UAV images from extensive calculations using the program that has been made and the existing provisions get a result of error of 7.256% on the first trial, the second experiment is 5.156%, and the third experiment is 3.126%.**

Keywords—Unmanned Aerial Vehicles, Convolutional Neural Network, super pixel

I. INTRODUCTION

Current technological developments are running very fast in almost all aspects. One of them is technology utilization in the geographical mapping of a region. Geographical information is one of the important and very necessary aspects for some parties in certain circumstances, such as mapping land functions from an area [1].

Mapping of land from a certain area can be done using digital imagery with a shooting technique called photogrammetry. Photogrammetry is an art, science, and technology to obtain reliable information about physical objects and the environment through the process of recording, measuring, and interpreting photographic images and recorded patterns of electromagnetic energy [2] One of the problems that can be solved by photogrammetry is in the field of forestry, namely efforts to monitor forest land such as counting the number of trees and calculating the percentage of green land in an area by utilizing digital imagery.

Digital image classification aims to group all pixels contained in an image into a class of land cover that has different spectral characteristics. The image of a region can be obtained by shooting through the air. Remote sensing of unmanned aerial vehicles (UAVs) has great potential for mapping vegetation in complex urban landscapes due to ultra-high resolution images obtained at relatively low altitudes.

From the explanation above, the authors design and create a system that can map and classify an area, especially green open land. This system can calculate the number of trees and can help determine whether or not enough green land or green open space in a region. The results obtained in the form of a percentage of green land to the total area of land in the area.

II. METHODOLOGY

The purpose of this research is to classify between a trees and no tree using Convolution Neural Network (CNN) so that the drone can capture an image automatically and calculate percentage of green open space. This research is applied to count the number of trees and can help know enough or not green open space in a given area of yield is in the form of a percentage of green land to the total land area in the region.

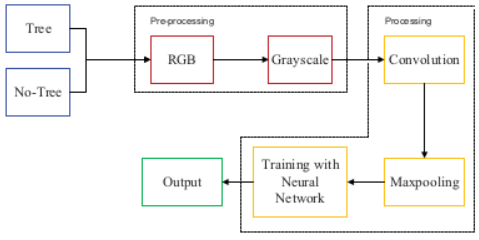

Fig. 1. Block diagram for training CNN

A. RGB

RGB color space is the main three colors (the three primary colors) which consists of three color channels, red, green, and blue. Each color channel is limited to a value of

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0 - 255 or in other words there can be 256 levels [3]. If the color channel is combined then there are 256 x 256 x256 or 16,777,216 RGB color combinations produced.

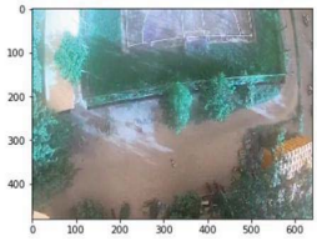

Fig. 2. Example of an RGB image

B. Grayscale

A grayscale image is an image that only has a gray level color. In this process the grayscale image is used for the information given to each pixel compared to the color image [4]. Gray color can be said as a color with one color channel, which is an 8 bit color channel.

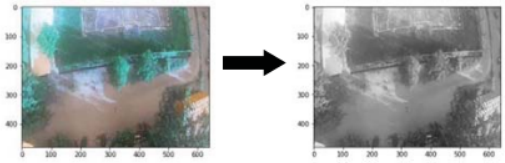

Fig. 3. The process of converting RGB to grayscale

C. Convolution

Convolution is a filtering image process that is often carried out in image processing. In this study, using a 5x5 convolution carnelian with a 640x480 gray image. In the image convolution stage, the author convolutes using the kernel twice to clarify the image so that it will get a more detailed image [5]. The first convolution process uses gray images with a size of 640x480 and 32 kernels which produce a new array measuring 638x478. The second convolution sized 319x239 and 64 kernels gray image shows a new array of 317x237.

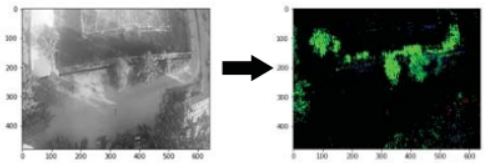

Fig. 4. Convolution process

D. Maxpooling

After passing through the convolution process, the next stage is RELU layer will implement the activation function elements, such as max (0, x) Thresholding zero [6]. So, if the pixel value is less than zero then it will be switched equal to zero. Subsampling layer is the process of reducing the size of an image data. In image processing, subsampling also aims to improve the position invariance of features [7]. In most of CNN, subsampling method used is the max pooling. The convolution layer has max pooling output that divided into smaller grids. Then the maximum value each grid is used to compose the reduced image matrix as shown in Fig. 5. The results of this process can be seen on the set of the grid on the right. Even though the object translated is shifted, this process will get the same features.

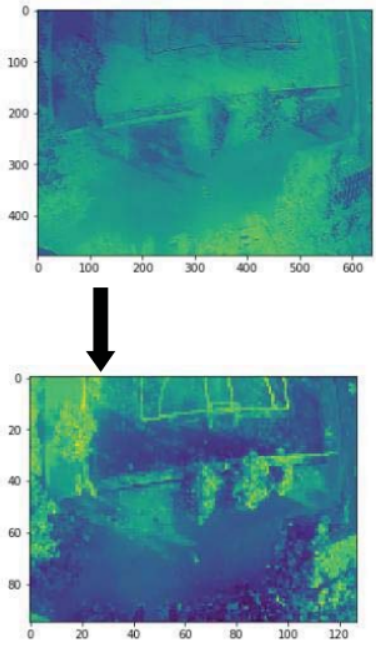

Fig. 5. Maxpooling process

E. Training Neural Network

On Supervised Learning using a Neural Network, it generally consists of two stages, namely training and evaluation. But there are also additional stages, namely testing, but this stage is not mandatory. In the training stage, the author will update the weight and bias on each neuron continuously so that the output produced is in line with expectations. In each iteration an evaluation process will be carried out which serves to determine the time the training process has been completed (stopping point) [8].

In the next part, we will discuss how to process training on the neural network. But it will be explained in general. The training process consists of 2 stages: Forward pass or forward propagation is a process whereby we carry data at the input passing through each neuron in the hidden layer to the output layer, which will then calculate the error. And the error we get on the forward pass will be used to update each weight and bias it with a particular learning rate or can use an auto learning rate [9].

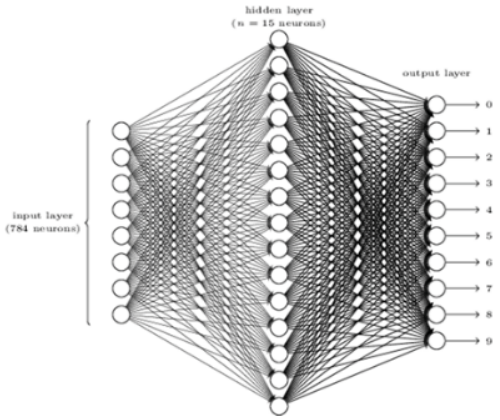

Fig. 6. Example of the structure of Neural Network training

F. Hardware

Fig.7 shows some of hardware that is used in this research. PC is used as a central processing unit where almost all of tasks are processed. The task of this program are displaying, capturing, classifying, filtering, and calculate the percentage of green openspace. The results of the classification will trigger programs that have been made to capture images through drones with action cam that has been placed on the drone. To capture the signal from the camera a dual band Wi-Fi extender is needed for a more extended range.

Fig. 7. Hardware

III. TESTING AND DATA ANALYSIS

Data testing uses the CNN method to classify and color thresholding to calculate the percentage of green open areas in an area.

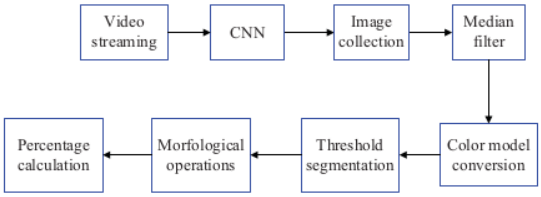

Fig. 8. System block diagram

A. Video Streaming

What is meant by video streaming in this paper is to connect between the action of the camera and the laptop using the dual band 5ghz Wi-Fi extender [10]. Then the laptop will get an IP from the action cam that will be accessed using Visual Studio 2017.

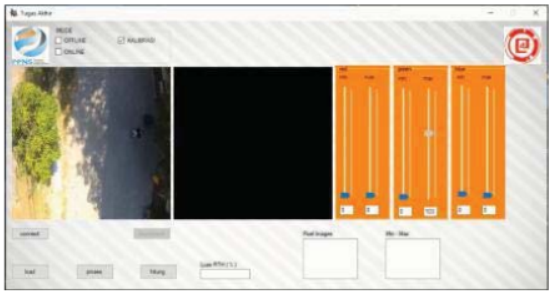

Fig. 9. Interface used for video streaming

B. CNN

This paper is focused on getting an automatic system tree classification, whether or not there is. In addition, the main purpose of this study is to obtain the classification results of the CNN process. Then it will trigger to capture the image automatically which will be processed later.

C. Noise Reduction

Since impulse noises generated by sensor or communication errors usually corrupt images, noise reduction is essential for improving the results of subsequent processing such as image segmentation and morphological operations[11]. In this paper, median filter (a widely used nonlinear digital filtering technique) is adopted to eliminate noise in images due to its simplicity and capability of preserving image edges while removing noise [12].

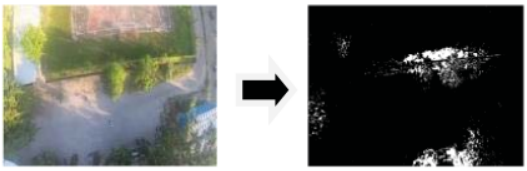

Fig. 10. Noise reduction process for captured images

D. Green Open Space Segmentation

Segmentation is an important step for Percentage Calculation. Its main objective is to differentiate green open space pixels from background pixels. Thresholding is a frequently adopted technique to segment the green open space regions in images, while Otsu method is one of the widely adopted thresholding approach for image segmentation. [13]

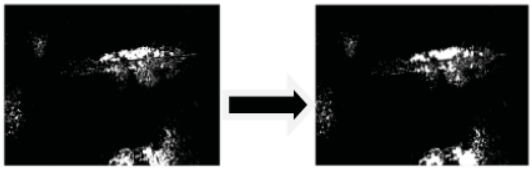

Fig. 11. The result of the image threshold process

E. *Morphological Operations*

Although noise reduction, color model conversion, and green open space segmentation have been applied, there still exist some small irrelative objects, which may affect the green open space confirmation. In this paper, the solution to this is to employ the mathematic morphological operations to remove the small objects which are not target objects in the percentage calculation.

There are several operations in mathematical morphological operations such as dilation and closing, as well as removing irrelative small objects in the thresholding image effectively. This paper applies dilation, since erosion can't get rid of pixels on the object boundaries while dilation can add pixels.

The erosion operation E and dilation operation D between image set I and morphological element C can be separately illustrated as follows:

$$E = I \otimes C| = \{(i,j)|C_{ij} \subseteq I\} \quad \text{(i)}$$

$$D = I \oplus C = \{(i,j)|[(\hat{C})_{i,j} \cap I] \neq \emptyset \quad \text{(ii)}$$

Where symbol "⊗"denotes the erosion operation and symbol "⊕"denotes dilation operation. *(i,j)* denote the coordinates of pixel in image *I* [14].

F. *Percentage Calculation*

After the image is processed using morphological operations, the next step is to find out what percentage of the openspace green area is in an image. To find out what percentage. The author uses pixel summing to find out the number of existing green open areas [15]. After that the author divides the sum of the green open area using the existing pixel area. For the results of the image can be seen in Fig. 12.

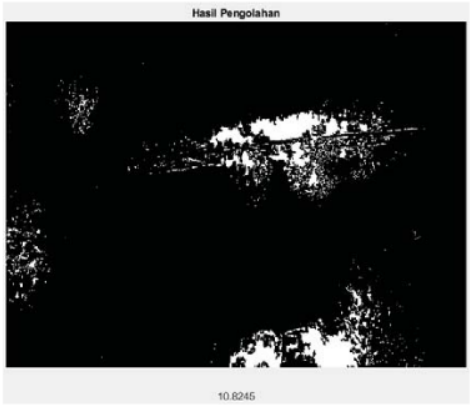

Fig. 12. The final result of calculating the percentage of green open space

IV. CONCLUSION

In this paper convolution neural network can predict the presence absence of trees with accuracy up to 90.35% by using the convolution process fourth. The first convolution process uses 32 kernels while the second convolution process uses 32 kernels. And the third convolution process uses 64 kernels while the fourth convolution process uses 32 kernels.

For the calculation of the accuracy of detecting the percentage of the number percentage of trees in one picture it has an error of 0.76% in the evening, and 4.045% in the afternoon, compared to the existing manual calculations. These results indicate that convolution can determine the presence or absence of trees.

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