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To cite this article: Huda Ubaya *et al* 2019 *J. Phys.: Conf. Ser.* **1196** 012061

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Developing Tree Height Calculation by Using Aerial Photographs for Monitoring Results of Revegetation Ex-mining Land Based on Government Regulation in Indonesia

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Abstract. Many private companies owned by individuals, the Indonesian state-owned enterprises or by foreign parties have been operating on coal mining in Indonesia. With so many coal mining companies in Indonesia, it is necessary to regulate the rules for the closure of ex-mining land. If it is not regulated, the process of closing the ex-mining land can have an impact on the destruction of the forest or natural ecological system. The government has issued several regulations to protect against this damage. One of regulation is measuring the width and layer of the canopy the tree at the certain age. This indicator is also measuring a height of the tree. Until this day, the officer from the government and companies is using stick measurement (manual measurement) to do this. However, this manual measurement is not accurate especially for an area with hills or landslide and takes time. With this problem, we are offering the measurement for special condition by using UAV which is Multi-Rotor with a camera. This UAV is taking an image of the tree then calculate the height by using triangle similarity Method. The results show that using this method the difference result from real measurement with the application is 2.6%

1. INTRODUCTION

Indonesia knows as an exporter of thermal coal that consists of medium quality (5100-6100 Cal/gram) as well as low-quality (<5100 Cal/Gram). This Thermal Coal has large demand imported by China and India. Based on the latest data from the Geological Agency of the Ministry of Energy and Mineral Resources (ESDM), Indonesia's coal reserves reached 26.2 billion tons with coal production of 461 million tons last year, the life of coal reserves is still 56 years if it is assumed that there are no new reserves [1]. There are three regions in Indonesia that are producing thermal Coal, which are South Sumatera, East Kalimantan and South Kalimantan (Fig. 1). However, there is numerous smaller mine of coal that digging in the island of Kalimantan, Sulawesi, Sumatra, Java, and Papua.

Fig 1. Several regions that are producing the amount of thermal Coal.

Indonesian coal mines controlled by foreign and private companies, while Indonesian state-owned enterprises (BUMN-*Badan Usaha Milik Negara*) only become a minority in managing coal mines. So, the Indonesian Government should protect the environment to control the Foreign, Private or even the BUMN. The Government has published the regulations which are *MoF Decree No P4/MenHut-II/2011* Concerning Forest Reclamation Guideline, *MoF Decree P60/MenHut-II/2009* about Guidelines on the Success of Forest Reclamation, and *ESDM Decree No 7/2014* Concerning Reclamation and post-mining Implementation on Mineral and Coal Mining Business Activities. There are 24 points that should comply with companies that resume by those regulations. The resume of Ministerial regulations of rehabilitation and reclamation of the post-coal mining areas in Indonesia to ecological restoration criteria and Indicators is showing in Table 1.

Some of the valuation indicators in biodiversity recovery are width and layer measurement of the canopy at the certain age. These indicators are only regulated in ESDM Decree No 7/2014. Currently, the tree measurement procedures (width, height, and layers of canopy) are carried out manually by human/officer as shown in Fig.2. This manual measurement is not accurate especially for areas with hills or landslide and time-consumed. The shortcomings of manual tree's measurement can be overcome by our methods of aerial photographs using a drone.

Fig.2. Measuring Height of the planted tree in post-mined land

2.   DATA AND METHODS

In this Section, the experiment was conducted in Inderalaya, Ogan Ilir, South Sumatera with some steps (setup experiment) and using 3 types of images data and also an explanation of the method for measuring the height of a tree.

A. SETUP EXPERIMENT

In this section, described the experiment that was conducted with several steps, these steps need to determine for minimizing the problems to be encountered.

A1.   Setup Unmanned Aerial Vehicle (UAV) with a Gimbal Camera

The UAV needs to apply in measuring the height of the tree in hilly and valley area as the benefit of using UAV for this application could reduce time-consuming and more precise than manual measuring by using stick ruler. UAV is one of the unmanned air crawler robots. UAV must be controlled remotely using remote control, commonly called Remotely Piloted Vehicle (RPV). In addition, UAV can also move automatically according to the program set [3]. According [4], UAV consists of several types such as Multi-Rotor, Fixed Wing, Single-Rotor, and Fixed-Wing Hybrid.

In this Experiment, Multi-Rotor (hexa-rotor) is applied base on the description of its Typical of uses in table 2.

TABLE 1. The Indonesian Ministerial Regulations In Relation to Ecological Restoration Criteria and Indicators [2]

Ecological Restoration Criteria	Valuation Indicators	MoF Decree No P4/MenHut-II/2011 Concerning Forest Reclamation Guideline	MoF Decree No P60/MenHut-II/2009 concerning Guidelines on the Success of Forest Reclamation	ESDM Decree No 7/2014 Concerning Reclamation and post-mining Implementation on Mineral and Coal Mining Business Activities
Biodiversity Recovery	Explicitly or Implicitly in Regulation			✓
	Number of Plant Species per Hectare (Species composition)		✓	
	Width and layer of the canopy at the certain age			✓
	Distribution of Plant diameter at the certain age			
Soil Remediation	Explicitly or Implicitly stated in the Regulation			✓
	The Thickness of the topsoil layer Soil quality	✓		
	Soil quality			✓
	Erosion prevention	✓	✓	✓
	Control of acid mine water		✓	✓
	Special treatment of toxic to soil	✓		✓
Planting of Local Plant	Explicitly or Implicitly stated in the Regulation			✓
	Native Habitat of plant species	✓	✓	✓
	Percentage per Hectare		✓	
Prohibition of Planting Invasive Exotic Plant Species	Explicitly or implicitly stated in the regulation			
	Strict sanction			
Monitoring and Evaluation	Explicitly or implicitly stated in the regulation	✓	✓	✓
	Methods	✓	✓	✓

A2.   Camera

The camera is a critical part of this experiment due to its function for taking an image as an Input to the system [5]. Because of this critical part, the comparison between two cameras such as RunCam HD

and Xiaomi Action Cam needs to be done for validating the result from the methods besides manual calculation.

Table 2. The difference UAV Types and its typical uses [4].

UAV Types	Typical of uses
Multi-Rotor	Aerial Photography and Video Aerial Inspection
Fixed Wing	Aerial Mapping, Pipeline and Powerline inspection
Single-Rotor	Aerial LIDAR laser scanning
Fixed-Wing Hybrid	Drone Delivery

A3.   Program Design

Program design is describing as a method that accommodates design flowing and documenting methods and also procedure inside an application or software. There are particular parts that should consider in Program Design which are Framework, Planning System, Software Planning and Interface Planning.

B. METHODS

The Image is taken by UAV-Multi-Rotor than the process using Image Segmentation method to separate the object tree with the background. The result of this process is a digital image (Binary). the next step is measuring the size of the image binary. This size is needed for calculating the image size. The formula for calculating the image size is showing if equation (1).

$$Image\ Size = \sqrt{m^2 + n^2} \quad \dots\dots\dots\dots\dots\dots\dots (1)$$

After calculating the image size, the next step is calculating the height of the tree shadow on the camera (Height Image Shadow). The formula to do this is showing in equation (2).

$$Height\ Image\ Shadow = \frac{Sensor\ Size}{Image\ Size} \quad \dots\dots\dots\dots\dots\dots.. (2)$$

The next step is finding the real height of the tree by using triangle similarity Method. The process of calculating the object height refers to the triangle consisting of a shadow calculation process by using special rays on the convex lens contained in a camera [6]. The formula of triangle similarity method showed in equation (3), (4), and (5).

$$\frac{x_1}{y_1} = \frac{x_2}{y_2} \quad \dots\dots\dots\dots\dots\ (3)$$

$$x_1 = \frac{y_1 \cdot x_2}{y_2} \quad \dots\dots\dots\dots\dots (4)$$

$$y_1 = \frac{y_2 \cdot x_1}{x_2} \quad \dots\dots\dots\dots\dots (5)$$

Where :

X_1 = *The distance of objects to the camera*
Y_1 = *Actual object height*
X_2 = *Focal length camera*
Y_2 = *Object height at cameras (its shadow)*

The object distance (X_1) is describing as the length between a real object to the Focal Plane (principal focal point), and the Object height at Camera (Its Shadow-Y_2) is describing as an object Shadows in a camera that is the result of a projection of a lens. This explanation can be described as an illustration in Fig. 3.
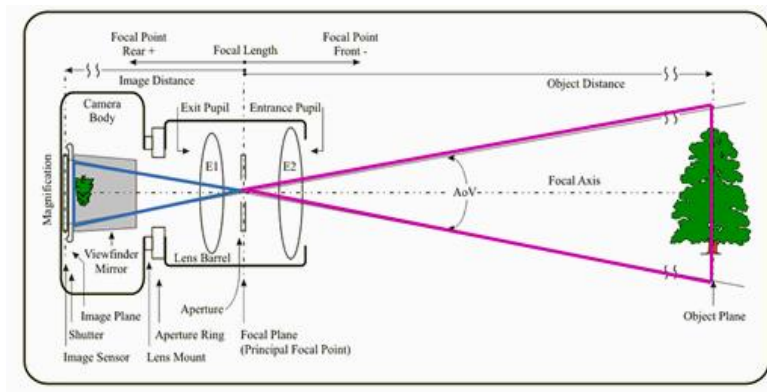
Fig. 3. Illustration of triangle similarity method camera

In order to structure the algorithm for measuring the height of tree, as explained above, the simple steps are shown in Fig. 4.

Algorithm measuring the tree Height by using triangular Similarity method

First Step:
- Calculate Image Size

$$Image\ Size = \sqrt{m^2 + n^2}$$

Second Step:
- Calculate Height of Shadow Object inside on camera

$$Height\ Image\ Shadow = \frac{Sensor\ Size}{Image\ Size}$$

Third Step:
- Calculate the real Height of Object by using triangular similarity Method

$$\frac{x_1}{y_1} = \frac{x_2}{y_2}$$

Fig. 4. The Algorithm that using for measuring the height tree.

C. DATA

The input data that used in this experiment divided into 3 types, which are:
1. Photographic Picture was taken by using Multi-Rotor.
2. Manual Data, this data is using for manual calculation by using the equations (1), (2), (3), (4) and (5).
3. Using Stick measurement for taking data of the height of the tree. This data using for validating the results from the application.

3. RESULTS

The experiment was conducted in Inderalaya, Palembang. The Multi-Rotor is setting with the first camera which is Xiaomi Action camera to taking a sample image of the tree. After the first capture, the next capture is replacing the Xiaomi Action Camera with RunCam camera. All the image capture that transferred into a Laptop that has developed an application which is built by using program language C++.

The results of the two cameras are showing in Fig. 5. These calculations of the software have a different, as the first experiment shows the real height of the tree is 4.613 meter, and the second camera shows 4.863 meters. These results are also similar to manual calculation, however, when using the stick meter, the height of a tree is giving 5 meters.
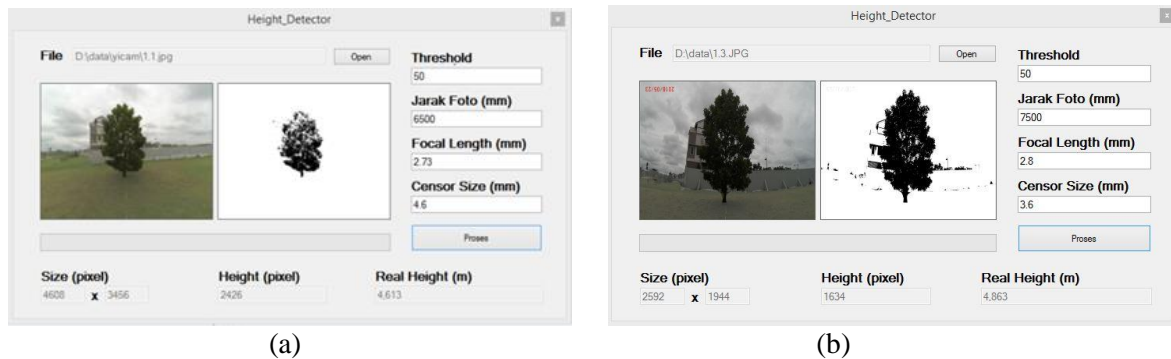
Fig. 5. The Height of Tree output by (a) Xiaomi Action Cam, (b)RunCam HD camera

A number of images have captured the same tree by using two cameras and calculated to find a mean of the results. The results are putting in a tabulation Table 3. This table is for finding a percentage of results from two cameras.

Based on the height of tree measurement using the application and manual measurement using the stick meter obtained almost the same result between the manual measurement and the calculation applied in an application. The better results in measuring the tree are showing using RunCam HD camera, this has 2.6% difference with a real height.

Table 3. The Tabulation table of Mean results from several experiments.

Real Height (Stick measurement) -Meters-	Mean of Height (Xiaomi Camera) -Meters-	Mean of Height (RunCam Camera) -Meters-
5	4.59	4.87
Percentage	91.8 %	97.4 %

4. CONCLUSION

The Measuring a tree is a part of the regulation that government rules protect an ecological and environment of the coal mining, this measuring need to conduct for calibrating the claim of the company about their program of revegetation. The application was built by using C++ programming for helping the government official to do their job for an area of hills or landslide. The Final results are showing that by using Multi-Rotor with RunCam HD camera and calculate with the formula of triangle similarity method is more precise with a difference of 2.6 % to real height.

REFERENCES

[1]. Ministry of Energy and Mineral Resources (2018), "Cadangan Batubara Indonesia Sebesar 26 Miliar Ton".
Accessed on Agust 2018 at https://www.esdm.go.id/id/media-center/arsip-berita/cadangan-batubara-indonesia-sebesar-26-miliar-ton

[2]. Ardiyanto W. Nugroho & Ishak Yassir (2017), "Kebijakan Penilaian Keberhasilan Reklamasi Lahan Pasca-Tambang Batubara Di Indonesia (*Policy Study on Post Coal Mining Reclamation Assessment in Indonesia*)". Jurnal Analisis Kebijakan Kehutanan Vol. 14 No.2, November 2017: 121-136. p-ISSN 0216-0897;e-ISSN 2502-6267; Terakreditasi No. 755/AU3/P2MI-LIPI/08/2016

[3] Y. S. Lim, P. H. La, J. S. Park, M. H. Lee, M. W. Pyeon, and J.-I. Kim (2015) "Calculation of Tree Height and Canopy Crown from Drone Images Using Segmentation," J. Korean Soc. Surv. Geod. Photogramm. Cartogr., vol. 33, no. 6, pp. 605–614.

[4] Andrew Chapman,(2016) "Types of Drones: Multi-Rotor vs Fixed-Wing vs Single Rotor vs

Hybrid VTOL" Drone Magazine, Issue 3.

[5] Passarella Rossi., Arsalan Osvari (2016), " Object Reconstruction from 2D Drawing Sketch to 3D Object", Computer Engineering and Application Journal, Vol 5 No 3 PP:119-126.

[6] Zulkahri, W. Lulu Dewi Yohana, Akbar Memen. (2014), "Perancangan dan Implementasi Pengukuran Jarak dan Tinggi Objek Berbasis Kamera pada Perangkat Mobile" Teknik Informatika, Komputer, Politeknik Caltex Riau, Pekanbaru.