PAPER • OPEN ACCESS

Image processing analysis of geospatial uav orthophotos for palm oil plantation monitoring

To cite this article: F Fahmi *et al* 2018 *J. Phys.: Conf. Ser.* **978** 012064

Image processing analysis of geospatial uav orthophotos for palm oil plantation monitoring

F Fahmi [1], D Trianda[1], U Andayani[2] and B Siregar[2]
[1]Department Electrical Engg, Faculty of Engineering, University of Sumatera Utara, Jl. Dr. Mansur 9 Medan Indonesia
[2]Department Information and Technology, Faculty of Computer Science and Information Technology, University of Sumatera Utara, Jl. Dr. Mansur 9 Medan Indonesia

Email. fahmimn@usu.ac.id

Abstract— Unmanned Aerial Vehicle (UAV) is one of the tools that can be used to monitor palm oil plantation remotely. With the geospatial orthophotos, it is possible to identify which part of the plantation land is fertile for planted crops, means to grow perfectly. It is also possible furthermore to identify less fertile in terms of growth but not perfect, and also part of plantation field that is not growing at all. This information can be easily known quickly with the use of UAV photos. In this study, we utilized image processing algorithm to process the orthophotos for more accurate and faster analysis. The resulting orthophotos image were processed using Matlab including classification of fertile, infertile, and dead palm oil plants by using Gray Level Co-Occurrence Matrix (GLCM) method. The GLCM method was developed based on four direction parameters with specific degrees 0°, 45°, 90°, and 135°. From the results of research conducted with 30 image samples, it was found that the accuracy of the system can be reached by using the features extracted from the matrix as parameters Contras, Correlation, Energy, and Homogeneity.

1. INTRODUCTION

Image processing today has a vast spectrum of applications in various fields of life including in the fields of biomedicine [1], astronomy, archeology, biometrics [2], daily life [3,4] image and document archives, industry and remote sensing using satellite imagery technology[5] .

Utilization of satellite imagery has been done mainly to identify changes in shape, extent or other conditions of a specific region. In this study, we utilized Unmanned Aerial Vehicle (UAV) to get geospatial orthophotos for monitoring oil palm plantations. The aim is to check the growth of oil palm plants from the beginning, in order to identify which part of the plantation land is fertile for planted crops which mean to grow perfectly, less fertile in terms of growth but not perfect, or not growing at all. This information can be known quickly by the using of UAV geospatial orthophotos.

In previous research conducted by Rizatus Shofiyanti (2011) [6], they utilized the image of UAV for indraja application for monitoring agricultural land. Muhammad Rendana et al. have established a system to detect palm oil nutrient stress, and Salim Malek (2014) examines the UAV image to detect palm oil rods [7,8].

A UAV or an unmanned aircraft is an unmanned flight or a glyph which can be controlled by a remote control or even with autonomous self-control. Unmanned drone controls are two main variants, the first variation being controlled via remote control and a second variation is a plane that flies independently according to the program included before flying [9].

IOP Conf. Series: Journal of Physics: Conf. Series **978** (2018) 012064 doi:10.1088/1742-6596/978/1/012064

An orthophoto is a kind of photographic map, which is quite possible to perform measurements as if it were a standard map. It is part of the photogrammetry field and is generally performed by Unmanned Aerial Vehicles (UAV). The resulting orthoimage can be synchronized with other maps containing other urban or technical elements such as agriculture or plantations, power grids, dams, etc. Example of orthophotos can be seen in Figure 1.

Geospatial or geo-space is a spatial aspect which indicates the location and position of an object or event that is under or on the surface of the earth expressed in a particular coordinate system. Geospatial data is data about geographic location, dimension or size, and / or characteristic of natural and / or man-made objects located below or on the surface of the earth [10].

Image or photo interpretation is an action to examine a photographic image for the purpose of identifying the object and assessing the significance of the image or photograph. Image interpretation is a process of recognizing objects in the form of images (images) for use in certain disciplines such as geology, geography, and other disciplines.

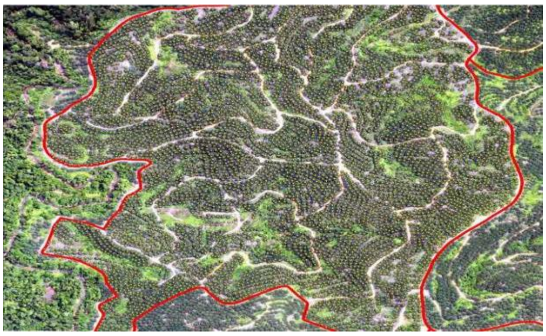

Figure 1. Example of Orthophotos mapped by UAV

The purpose of this study was to develop an orthophotos image analysis for monitoring vegetation within this palm oil plantation. The aim is to automatically measure the area of palm oil plantation and classify it into three categorize : fertile, nonfertile and no grow area.

2. MATERIAL AND METHODS

Digital image processing is work to process and analyze a digital image that involves a lot of image data in the form of pixel representation. The stage of pre-processing is part of the preparation for digital image processing to be analyzed later on. Several methods can be done as part of the preparation of the image in accordance with the needs of the next process.

2.1 Image Segmentation and Extraction

Image segmentation is an important step in the pattern recognition process. Once the object is successfully segmented, then we can perform the image character extraction process. Characteristic extraction is a stage that aims to extract the characteristics of an object in which the trait is used to distinguish between one object to another object.

This characteristic extraction process relates to the quantization of image characteristics into a set of corresponding feature values. One technique for obtaining statistical features is to calculate the probability of an adjacency relationship between two pixels at a certain distance and angular orientation. This approach works by forming a co-occurrence matrix from the image data, followed by defining the feature as a function of the intermediate matrix.

2.2 Gray Level Co-Occurrence Matrix (GLCM)

GLCM is a matrix whose elements are the number of pixel pairs that have a certain degree of brightness, in which the pixel pair is separated by a distance d, and with an inclination angle θ [11]. In other words, the co-occurrence matrix is the probability of the appearance of gray level i and j of two separate pixels at distance d and angle θ. Orientation is formed in four angular directions with 45 ° angle intervals, i.e., 0 °, 45 °, 90 °, and 135 °. While the distance between pixels is usually set by 1 pixel. These four directions can be represented in Figure 2.

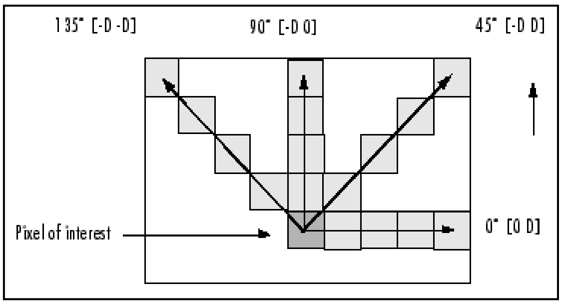

Figure 2. Direction of Gray level Orientation

Co-occurrence means a common occurrence, i.e., the number of occurrences of one level of pixel value adjacent to one level of another pixel value in the distance (d) and a certain angular orientation (θ). Distance is expressed in pixels and orientation expressed in degrees.

Haralick et al. proposed various types of textural characteristics that can be extracted from the co-occurrence matrix, namely Angular Second Moment, Contrast, Correlation, Variance, Inverse Difference Moment, and Entropy (Haralick, K. Shanmugam, and I. Dinstein, 1973).

$$ASM = \sum_i \sum_j \{p(i,j)\}^2 \quad \text{.......................} (1)$$
$$CON = \sum_k k^2 \left[\sum_i \sum_j p(i,j)\right] \quad \text{...............} (2)$$
$$COR = \frac{\sum_i \sum_j (i,j) . p(i,j) - \mu_x \mu_y}{\sigma_x \sigma_y} \quad \text{..................} (3)$$
$$VAR = \sum_i \sum_j (i - \mu_x)(j - \mu_y) p(i,j) \quad (4)$$
$$IDM = \sum_i \sum_j \frac{1}{1+(i-j)^2} p(i,j) \quad \text{...............} (5)$$
$$ENT_2 = - \sum_i \sum_j p(i,j) . 2_{\log p(i,j)} \quad \text{......} (6)$$

In the above equation, p (i, j) denotes the probability, which starts from zero to one, i.e., the element value in the co-occurrence matrix. While i and j, denote the adjacent pair of intensities, which in each co-occurrence matrix becomes the row number and column number.

2.3 Classification

At the classification stage, palm oil will be classified based on three (3) categorize fertile, infertile and non-growing categories using the distance method, i.e., the Euclidean method as a classification method.

$$d_{Euc} = \sqrt{\sum_{i=1}^{n} (P_i - Q_i)^2} \quad \text{...........} (7)$$

Where Pi = Test image pattern and Qi = standard image pattern

2.4 Research Method

The research method is done with the following stages:

a. Preparation of Orthophotos Imagery

Image data retrieval is done by UAV / Drone type DJI 3 type Phantom (Figure 3)

Figure 3. UAV type Drone DJI 3 Phantom and its remote control

IOP Conf. Series: Journal of Physics: Conf. Series **978** (2018) 012064 doi:10.1088/1742-6596/978/1/012064

b. Calculation of the Area
The wide of specific area will automatically be determined when UAV / Drone is flown to retrieve image data from oil palm plantations [12].

c. Image Segmentation and Feature Extraction
Image segmentation and feature extraction were conducted to divide an image into objects into homogeneous regions based on the similarity between the gray level of a pixel to the gray level of its neighboring pixels. This step is included in the Feature Extraction process by entering scale level segmentation to determine what objects will be extracted. The image of the segmentation result is then extracted by the Gray Level Co-occurrence Matrix (GLCM) method, for each class of the object / segment that has been formed from the segmentation.

d. Classification
Classification is done by first input sample data for palm oil image in fertile category 10 sample, less fertile 10 sample and not grow 10 sample as the training set. The threshold value was obtained from the training session and then used as a parameter to classified the unknown area.

e. Data validation and testing
From the sample tested, it will be calculated are based on four features: Energy, Correlation, Contrast, and Homogeneity.

3. Results
The palm oil image data obtained from the drone type DJI phantom type is shown in Figure 4.

Figure 4. Palm oil Plantation captured by Drone

Table 1 shows the data of oil palm image used in this study.

Table 1. Palm Oil Image dataset

Palm Oil	Sample	Baseline	Format
Fertile	10	1	.jpg
Less Fertile	10	1	.jpg
Not Growing	10	1	.jpg

Examples of palm oil image for fertile, less fertile and not growing are shown in Figures 5 (a),(b), and (c).

(a) (b)

(c)

Figure 5. Palm oil Area (a) Fertile, (b) Less Fertile and (c) Not Growing

After the image data was cropped, the image will be changed into a matrix form that collects the pixel color of the gray image data and the direction value of the degree of image grayscale with 4 categories.

The results of testing for oil palm samples for fertile, infertile and non-growing areas can be seen in Table 2.

Table 2. Result of GLCM feature parameters

Image Dataset	Contrast				Correlation				Energy				Homogeneity			
Fertile Samples																
	0°	45°	90°	135°	0°	45°	90°	135°	0°	45°	90°	135°	0°	45°	90°	135°
Sample1	4,2118	7,6933	4,1154	6,1307	0,8692	0,7609	0,8723	0,8095	0,0113	0,0085	0,0113	0,0096	0,5223	0,4502	0,5242	0,4792
Sample2	3,4975	6,7414	3,6888	5,2860	0,8560	0,7228	0,8483	0,7827	0,0140	0,0105	0,0135	0,0116	0,5434	0,4635	0,5332	0,4908
Sample3	3,7022	6,9786	3,6815	5,3527	0,8327	0,6827	0,8322	0,7566	0,0140	0,0104	0,0135	0,0116	0,5389	0,4574	0,5274	0,4856
Sample4	4,0719	7,2346	3,7178	5,7002	0,8130	0,6653	0,8285	0,7363	0,0135	0,0103	0,0135	0,0112	0,5287	0,4560	0,5310	0,4770
Sample5	4,3881	7,3142	3,7905	6,1264	0,8179	0,6958	0,8425	0,7451	0,0126	0,0098	0,0133	0,0108	0,5261	0,4552	0,5397	0,4854
Sample6	3,5207	6,1008	3,3594	5,1056	0,8226	0,7004	0,8354	0,7492	0,0155	0,0119	0,0156	0,0130	0,5560	0,4832	0,5576	0,5088
Sample7	5,9551	11,2707	6,2329	8,5564	0,7969	0,6155	0,7883	0,7081	0,0094	0,0073	0,0092	0,0080	0,4794	0,4090	0,4750	0,4331
Sample8	5,7921	11,0510	5,9909	8,3755	0,8075	0,6321	0,8008	0,7212	0,0092	0,0071	0,0091	0,0078	0,4802	0,4083	0,4771	0,4325
Sample9	5,4995	10,8631	5,9411	7,8689	0,8095	0,6216	0,7925	0,7260	0,0101	0,0075	0,0096	0,0085	0,4896	0,4069	0,4721	0,4423
Sample10	6,3933	12,5300	6,9843	9,3393	0,8137	0,6348	0,7971	0,7278	0,0086	0,0064	0,0081	0,0071	0,4789	0,3984	0,4641	0,4264
Less Fertile Samples																
Image Dataset	Contrast				Correlation				Energy				Homogeneity			
	0°	45°	90°	135°	0°	45°	90°	135°	0°	45°	90°	135°	0°	45°	90°	135°
Sample1	2,9808	5,9216	3,3563	4,3456	0,8190	0,6419	0,7969	0,7370	0,0300	0,0234	0,0281	0,0253	0,5761	0,4992	0,5658	0,5319
Sample2	3,2708	6,4362	3,6381	4,8599	0,8149	0,6359	0,7948	0,7252	0,0261	0,0203	0,0247	0,0226	0,5654	0,4849	0,5489	0,5178
Sample3	5,4231	9,7542	5,4277	8,0278	0,8477	0,7278	0,8486	0,7759	0,0124	0,0097	0,0120	0,0106	0,5106	0,4417	0,5055	0,4659
Sample4	4,9593	8,9281	5,1490	7,7714	0,8482	0,7264	0,8425	0,7617	0,0184	0,0150	0,0180	0,0159	0,5396	0,4751	0,5321	0,4926
Sample5	3,4958	6,9842	3,8866	5,2175	0,8363	0,6727	0,8180	0,7555	0,0207	0,0160	0,0195	0,0179	0,5557	0,4784	0,5401	0,5118
Sample6	2,3976	4,8563	3,1086	4,4408	0,8783	0,7539	0,8419	0,7748	0,0241	0,0178	0,0215	0,0184	0,6068	0,5212	0,5732	0,5290
Sample7	4,2730	7,8296	4,4025	6,2405	0,8129	0,6592	0,8083	0,7285	0,0184	0,0144	0,0178	0,0158	0,5338	0,4608	0,5203	0,4844
Sample8	2,1865	4,2861	2,6293	3,5826	0,8695	0,7435	0,8423	0,7856	0,0294	0,0221	0,0267	0,0234	0,6128	0,5263	0,5816	0,5435
Sample9	3,7980	7,1455	4,0638	5,6712	0,8206	0,6634	0,8090	0,7328	0,0213	0,0166	0,0203	0,0179	0,5520	0,4805	0,5437	0,5019
Sample10	5,3022	9,5309	5,6343	8,5540	0,8400	0,7118	0,8294	0,7413	0,0151	0,0120	0,0148	0,0130	0,5164	0,4481	0,5098	0,4690
Not Growing Samples																
Image Dataset	Contrast				Correlation				Energy				Homogeneity			
	0°	45°	90°	135°	0°	45°	90°	135°	0°	45°	90°	135°	0°	45°	90°	135°
Sample1	2,5597	4,9242	2,9423	4,0216	0,8484	0,7088	0,8264	0,7621	0,0276	0,0212	0,0255	0,0227	0,5956	0,5162	0,5763	0,5366
Sample2	2,9963	5,9502	3,2870	4,4742	0,8577	0,7179	0,8439	0,7878	0,0154	0,0111	0,0145	0,0125	0,5676	0,4775	0,5509	0,5087
Sample3	5,6832	11,0656	6,2809	8,7417	0,8737	0,7541	0,8605	0,8056	0,0079	0,0059	0,0077	0,0066	0,4884	0,4138	0,4836	0,4406
Sample4	5,0802	9,8605	6,4220	9,2017	0,8872	0,7802	0,8569	0,7950	0,0093	0,0071	0,0087	0,0075	0,5078	0,4349	0,4912	0,4539
Sample5	7,5858	14,1140	8,0362	11,5997	0,8453	0,7115	0,8364	0,7629	0,0065	0,0048	0,0061	0,0052	0,4658	0,3931	0,4468	0,4091
Sample6	7,4790	14,0363	7,9481	11,2842	0,8514	0,7209	0,8423	0,7758	0,0064	0,0047	0,0061	0,0053	0,4663	0,3890	0,4478	0,4146
Sample7	2,7960	5,3915	3,1939	4,4329	0,8426	0,6967	0,8211	0,7508	0,0269	0,0207	0,0253	0,0225	0,5878	0,5075	0,5712	0,5328
Sample8	7,4931	14,4286	8,3382	11,5500	0,8471	0,7057	0,8299	0,7644	0,0063	0,0047	0,0060	0,0052	0,4630	0,3888	0,4443	0,4079
Sample9	5,3408	10,2140	5,8298	8,2820	0,8739	0,7593	0,8624	0,8048	0,0082	0,0061	0,0079	0,0068	0,4963	0,4199	0,4868	0,4470
Sample10	3,1493	6,6105	4,0308	5,3978	0,8967	0,7831	0,8677	0,8229	0,0163	0,0121	0,0149	0,0130	0,5660	0,4821	0,5413	0,4996

Of the three samples tested it can be seen that contrast for fertile samples is higher than the other two samples. As for the other three categories, the fertile sample has more of the same value than the two samples with less fertile and non-growing categories.

For more details, the difference can be seen in Figure 6 with direction 0° for four parameters Contrast, correlation, energy, and homogeneity. From Figure 6 it can be seen that the average value of the fertile area is higher than other categories.

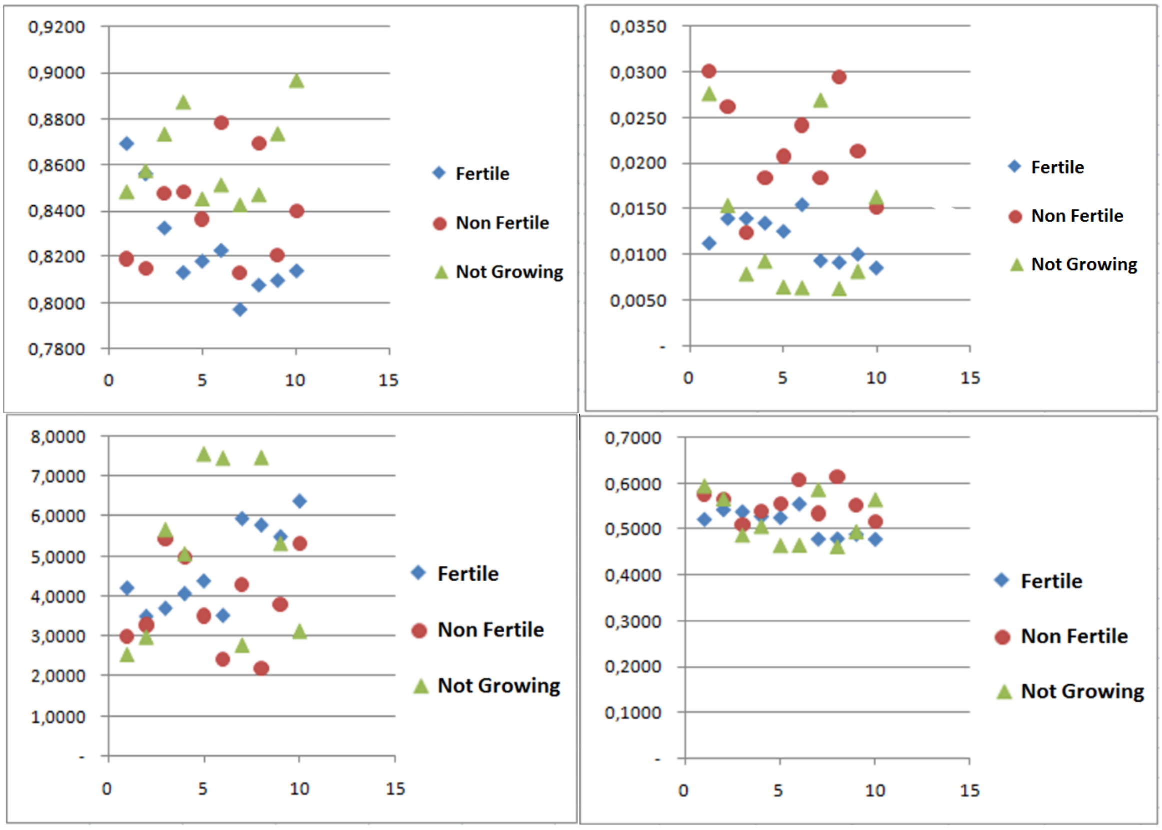

Figure 6. Feature Parameter value of GLCM with direction 0° (a) Contrast (b)Correlation (c) Energy (d) Homogeneity

4. Conclusion

From the research that has been done, it can be concluded that the use of UAV for monitoring of oil palm can identify the fertile area, less fertile and not grow automatically. The application can be made using GLCM method. From the results of research conducted with 30 image samples, it was found that the accuracy of the system can be reached by using the features extracted from the matrix as parameters Contras, Correlation, Energy, and Homogeneity.

References

[1] Fahmi F 2014 3D movement correction of CT brain perfusion image data of patients with acute ischemic stroke *Neuroradiology* **56:6** pp 445-452.

[2] Siswanto A, Tarigan P and Fahmi F 2013 Design of contactless hand biometric system with relative geometric parameters *Instrumentation, Communications, Information Technology, and Biomedical Engineering (ICICI-BME), 2013 3rd International Conference on* IEEE

[3] Triantoro T, Batubara R F and Fahmi F 2014 Image based water gauge reading developed with ANN Kohonen *Electrical Engineering and Computer Science (ICEECS), 2014 International Conference on* IEEE

[4] Muhammadiy W and Fahmi F 2016 Mobile application to differentiate flesh meat between beef and pork *Computational Intelligence and Cybernetics (CYBERNETICSCOM), 2016 International Conference on* IEEE

[5]Tarigan A P M and Fahmi F 2017 Mapping a Volcano Hazard Area of Mount Sinabung Using Drone: Preliminary Results *IOP Conference Series: Materials Science and Engineering* Vol **180** No 1 IOP Publishing

[6] Shofiyanti R 2011 Teknologi Pesawat Tanpa Awak untuk Pemetaan dan Pemantauan Tanaman dan Lahan Pertanian, *Inform Pertan* , vol **20**, no 2, pp 58–64

[7] Guldogan O, Rotola-pukkila J, Balasundaram U, Le T and K Mannar 2016 Automated Tree Detection and Density Calculation using Unmanned Aerial Vehicles *Vcip2016* pp 4–7

[8] Moranduzzo T and Melgani F 2014 Monitoring Structural Damages in Big Industrial Plants With Uav Images pp 4950–4953

[9] Emirul B 2015 Drone 1 pp 1–19

[10] Mitchell J J, Glenn N F, Anderson M O , Hruska R C and Charlie A H 2012 Unmanned Aerial Vehicle

(UAV) Hyperspectral Remote Sensing for Dryland Vegetation Monitoring Hyperspectral Image and Signal Sensing *4th Work Hyperspectral Image Signal Process*

[11] Saifudin and Abdul F 2013 Sistem Identifikasi Citra Kayu Berdasarkan Tekstur Menggunakan *Gray Level Co-occurrence Matrix* (Glcm) Dengan Klasifikasi Jarak Euclidean ISSN: 1410-233

[12] Hepi H and MariaRegina Caeli 2016 Studi Perhituungan Jumlah Pohon Kelapa Sawit Menggunakan Metode Klasifikasi Berbasis Obyek (Tugas Akhir, ITS)