



Intercontinental Geoinformation Days

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Application of UAV-Based multispectral images for accessing oil palm trees health using online AI Platform

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Keywords

Oil palms
Multispectral
Object extraction
UAV
Vegetation indices

ABSTRACT

The oil palms are a major product in Cambodia to export local and worldwide which provides job opportunities and develops infrastructure over there. In this study, two plots of oil palms have collected by Unmanned Aerial Vehicle (UAV). The Artificial Intelligence (AI) online platform has been used to extracting oil palm trees from very-resolution imagery. In extracting oil palm tree is applied Picterra platform that it has to bring AI-powered for object detection and geospatial analysis. In this way, oil palm trees are counting automatically and manually, the result shows that high overall accuracy by automatically. The oil palm tree health is estimated by using vegetation indices that it has such as Green Normalized Different Red Edge (NDRE), Normalized Different Vegetation Index (GNDVI), and Normalized Different Vegetation Index (NDVI). Vegetation indices maps have been created from UAV-based multispectral images. It has estimated oil palm tree health using Green, Red, Red Edge, and Near-Infrared bands from the multispectral camera. The vegetation indices have been compared with maximum, minimum, mean, and standard deviation in vegetation and chlorophyll content. The NDVI indices are better than NDRE and GNDVI. The spectral profile has been created in both plots based on the pixel value of vegetation indices of reflectance and absorption.

1. INTRODUCTION

Oil palms are the product of the agriculture sector in Cambodia. Colchester et al. (2011) mention that the area coverage of oil palm plantations is 1188,00 ha of Economic Land Concessions in Cambodia. Mong Reththy Investment Cambodia Oil Palm Co., LTD (MRICOP) is the first company that the company has been invested in oil palm plantations coverage 11000 ha in Cambodia since 1995, according to (Saing et al. 2012). Four estates (Estate A, B, C & D) have been planted oil palm trees. As of 2016, oil palm trees have been planted on 15173 ha.

In estimating oil palm trees are popular which utilize Unmanned Aerial Vehicle (UAV) in this era. UAV has become an application in Photogrammetry and Remote Sensing (Yu et al. 2017). UAV has been demonstrated in agriculture that it provides multispectral bands of Parrot Sequoia Multispectral camera sensor. The sensor has been delivered Green band, Red band, Red Edge band,

Near-Infrared band, and RGB camera. In the same way, (Raeva et al. 2019) assess those vegetation indices (NDRE, GNDVI & NDVI) with multispectral imagery from UAV. Therefore, multispectral imagery can be used in estimating oil palm tree health from UAV based on vegetation and chlorophyll content.

As shown above, UAV-based multispectral and very high-resolution imagery are essential for delivering into large oil palms area. The oil palm tree health is going to analyze a single tree and find where is allocated. Moreover, this research is going to apply UAV-based multispectral images to be detected and counted oil palm trees by using an online AI platform.

There are two objectives of the research as the following 1) to detect and count oil palm trees of very high-resolution images from UAV with an online AI platform and 2) to evaluate and compare oil palm trees health by Using NDRE, GNDVI, and NDVI indices in vegetation and chlorophyll content.

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Cite this study

Lay H, Zhenfeng S & Hor S (2021). Application of UAV-Based multispectral images for accessing oil palm trees health using online AI Platform. 2nd Intercontinental Geoinformation Days (IGD), 155-158, Mersin, Turkey

2. METHOD

2.1. Area of Interest (AOI)

The oil palms are the largest area in Cambodia, the study cannot be detected the whole area of it. So, the study is going to collect 2 plots of the oil palms farm by using the UAV (DJI Matrice 100) at Mong Reththy Investment Cambodia Oil Palm Co., LTD, Sihanoukville, Cambodia. The location of the study area’s latitude and longitude is 10.965651 North and 103.894319 East.

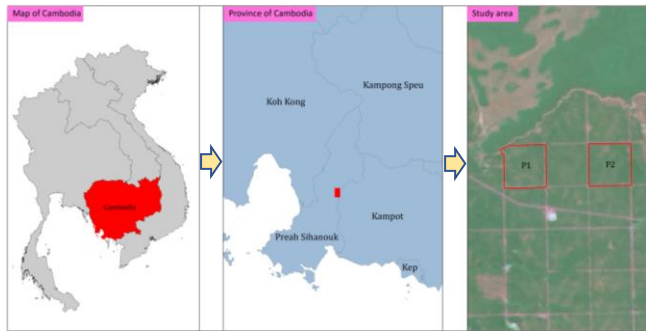


Figure 1. Map of the study area

2.2. Data Acquisition

Use DJI Matrice 100 to collect raw images of oil palm trees, that raw images get from RGB (Red, Green, and Blue bands) and multispectral camera (Green, Red, Red Edge, and Near-infrared bands (Table 1).

Table 1. DJI Matrice 100 flight planning

Plot	Front Overlap	Side Overlap	Height	Coverage
P1	75%	75%	150m	25 ha
P2	75%	75%	150m	25 ha

2.3. Research Framework

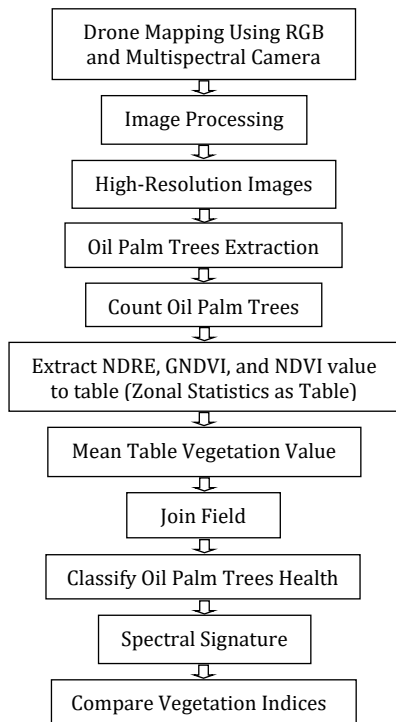


Figure 2. The workflow of the research

2.4. Vegetation Indices Calculation

The NDRE estimates tree leaf that it identifies chlorophyll absorption of Red wavelengths with the higher reflectance of NIR wavelengths, and the Red Edge wavelength to indicate chlorophyll content, according to (Carlson and Ripley 1997) (Equation 1).

$$NDRE = (NIR - REDGE) / (NIR + REDGE) \quad (1)$$

Where: NIR refers to Near-Infrared band and REDGE refers to Red Edge band.

According to (ESRI, 2020) Green Normalized Difference Vegetation Index (GNDVI) is a vegetation index that has been used in NIR and Green bands in estimating photosynthetic activity (Equation 2).

$$GNDVI = (NIR - Green) / (NIR + Green) \quad (2)$$

Where: NIR refers to the Near-Infrared band and Green refers to the Green band.

Karaburun (2010) explains that the well-known NDVI used for estimating green vegetation that refers to Normalized Different Vegetation Index (Equation 3).

$$NDVI = (NIR - Red) / (NIR + Red) \quad (3)$$

Where: NIR refers to the Near-Infrared band and RED refers to the Red band.

3. RESULTS & DISCUSSION

3.1. Oil Palm Trees Extraction

The result of oil palm tree extraction occurred in the polygon by using an online AI platform. The total of oil palm tree extraction of P1 is 4.70 ha and P2 is 4.10 ha. After oil palm trees are extracted, the next step counts the number of oil palm trees in both plots. Moreover, the number of oil palm trees counted automatically of P1 is 3456 trees and P2 is 3477 trees, and manually of P1 is 3447 trees and P2 is 3462 trees. See detailed at (Table 2) and on the map (Figure 3).

Table 2. Extracting and counting oil palm trees

Plot	Extraction	Automatically	Manually
P1	4.70 ha	3456 trees	3447 trees
P2	4.10 ha	3477 trees	3462 trees

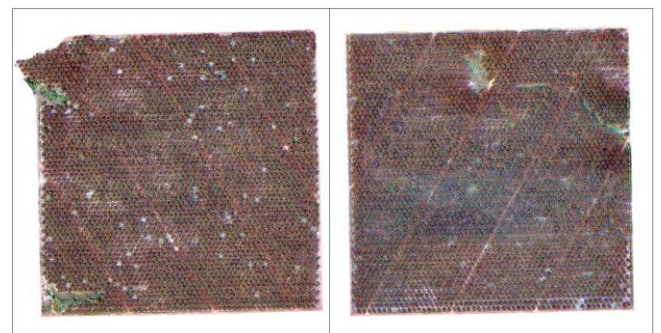


Figure 3. Map of oil palm trees extraction

3.2. Accuracy Assessment

The result of detecting oil palm trees is provided overall accuracy of P1 is 100% and P2 is 98.97%. Even though the oil palm tree detection appears high accuracy assessment but it shows missing detection and detects different objects. P1 is missing detection appears one oil palm tree and detects seven different objects on the unknown object. For P2 is missing detection appears one palm tree and fourteen different objects on the unknown trees. See detailed (Table 3).

Table 3. The overall accuracy of oil palm trees detection

Plot	Annotation	Testing	Training	Overall accuracy
P1	141	1	5	100%
P2	140	1	5	98.97%

3.3. Oil Palms Health Estimation

The result estimates oil palm tree health used and compared the vegetation indices that have Normalized Difference Red Edge (NDRE), Green Normalized Difference Vegetation Index (GNDVI), and Normalized Difference Vegetation Index (NDVI).

The NDRE used to identify leaf of oil palm tree that it called chlorophyll reflectance and absorbs at red edge and near-infrared. There are 3 classifies of oil palm trees chlorophyll estimation of P1 and P2 (Figure 4). P1 has such as low chlorophyll (0.14 – 0.29), medium chlorophyll (0.29 – 0.33) and high chlorophyll (0.33 – 0.44). P2 result shows that low chlorophyll (0.13 – 0.26), medium chlorophyll (0.26 – 0.31) and high chlorophyll (0.31 – 0.40).

GNDVI is determining water and nitrogen uptake into the plant canopy reflectance and absorbs at green and near-infrared. The classification for P1 is 3 classes and P2 is 3 classes of oil palm trees health estimation (Figure 5). P1 has such as unhealthy (0.41 – 0.65), moderately healthy (0.65 – 0.71), and very healthy (0.71 – 0.79). P2 shows on the map that moderately healthy (0.46 – 0.69) and Very healthy (0.69 – 0.78).

NDVI is estimated healthy by reflectance and absorbs at red and near-infrared. The classification for P1 is 3 classes and P2 is 2 classes of oil palm trees health estimation (Figure 6). P1 has such as unhealthy (0.33 – 0.71), moderately healthy (0.71 – 0.81), and very healthy (0.81 – 0.88). And P1 the result occurs that moderately healthy (0.54 – 0.81) and very healthy (0.81 – 0.88).

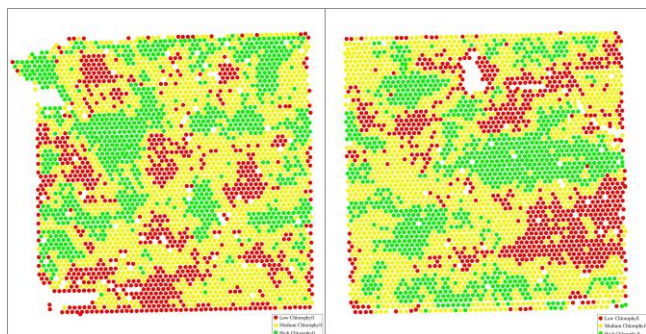


Figure 4. Map of NDRE



Figure 5. Map of GNDVI

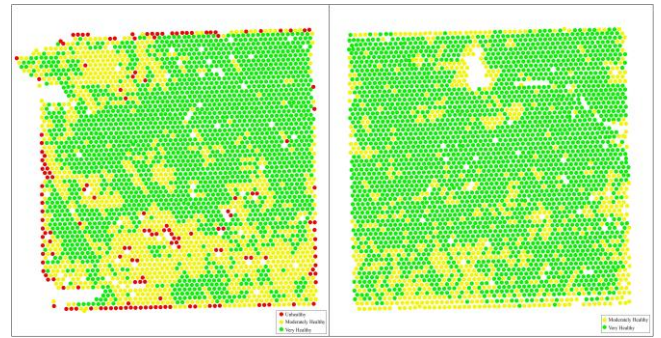


Figure 6. Map of NDVI

The compression of green band, red edge band, red band, and near-infrared band in the spectral signature of oil palm tree health based on GNDVI and NDVI indices. Use ten oil palm trees per one classify to compare the spectral profile of absorbs and emittance of each band. The result of P1 (Figure 7) shows that unhealthy absorbs low at Green and Red bands, and emittances low at Red Edge and Near-Infrared bands. Moderately healthy absorbs medium Green and Red bands, and emittances medium at Red Edge and Near-Infrared bands. Very healthy absorbs high at Green and Red bands, and emittances high at Red Edge and Near-Infrared bands.

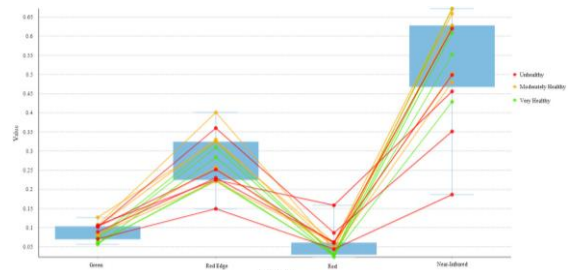


Figure 7. Comparison spectral profile of P1

Use ten oil palm trees per one classify to compare the spectral profile of absorbs and emittance. The result of P2 (Figure 8) shows that moderately healthy absorbs medium Green and Red bands, and emittances medium at Red Edge and Near-Infrared bands. Very healthy absorbs high at Green and Red bands, and emittances high at Red Edge and Near-Infrared bands.

After use vegetation index to estimate chlorophyll and health of oil palm trees. The result of P1 (Figure 9) shows that NDRE value Min is 0.14, Max is 0.14, Mean is 0.32, and Std Dev is 0.04. The value of GNDVI shows that Min is 0.41, Max is 0.79, Mean is 0.71, and Std Dev is 0.04. And the value of NDVI has such as Min is 0.33, Max is 0.88, Mean is 0.81, and Std Dev is 0.05.

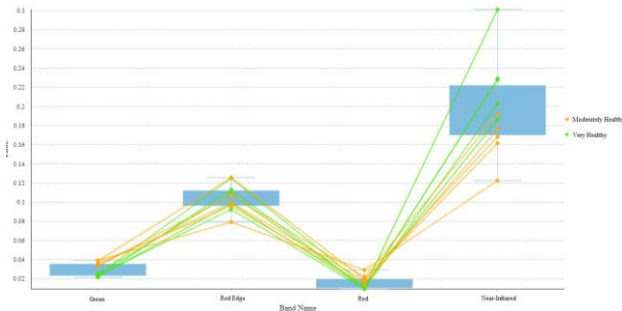


Figure 8. Comparison spectral profile of P2

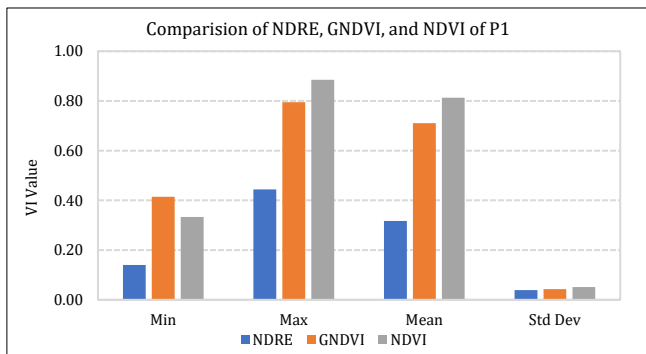


Figure 9. Comparison of vegetation indices of P1

The result of plot-2 (Figure 10) shows that the value of NDRE has such as Min is 0.14, Max is 0.41, Mean is 0.29, and Std Dev is 0.04. The value of GNDVI has such as Min is 0.46, Max is 0.78, Mean is 0.70, and Std Dev is 0.03. And the value of NDVI has such as Min is 0.54, Max is 0.88, Mean is 0.83, and Std Dev is 0.03.

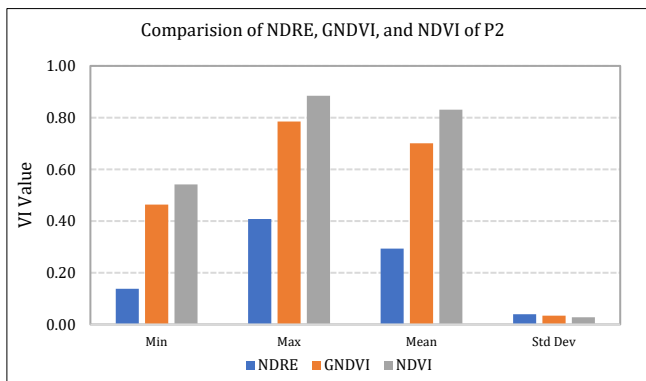


Figure 10. Comparison of vegetation indices of P2

4. CONCLUSION

In this research, a high-resolution image was applied to detect and count two plots of oil palm trees. A multispectral image was used to estimate and evaluate oil palm trees health at Mong Reththy Investment Cambodia Oil Palm Co., LTD, Sihanoukville Province, Cambodia. The high-resolutions was detected oil palm trees using an online AI platform found by Picterra. The comparison of NDRE, GNDVI, and NDVI indices in vegetation and chlorophyll content.

The result of oil palm tree extraction shows that the online AI platform is the performance for detecting area of interest in this study. It provided high accuracy in both plots but missing detection and detect different objects. Because a few objects are too small and blur, several

trees are a similar texture as the oil palm trees. Therefore, the result of oil palm tree extraction occurs in a polygon that circles every single oil palm tree.

The result of oil palm trees health estimation shows that all vegetation indices can be evaluated healthy of the oil palm trees. The NDRE was used to analyze the chlorophyll of the oil palm tree. GNDVI analysis was used to determine oil palm trees that occur water and nitrogen uptake into the plant canopy. And NDVI was used to calculate oil palm tree health based on the value range of the index. Moreover, after vegetations index was used to compare that NDVI is the best performance than NDRE and GNDVI. Because it can help differentiate bare soil from grass or forest, detect plants under stress, and differentiate between crops and crop stages.

The high-resolution image from UAV is very important for counting oil palm trees. The online AI platform is useful for extracting, it is too simple. It occurs high accuracy assessment after used to detect oil palm trees tow plots. It can generate a large area on the online interface. The farm can apply the vegetation index to calculate the whole of oil palm areas by using multispectral images. Therefore, the farm can manage and estimate the yield of oil palm trees to produce it for the consumer.

ACKNOWLEDGEMENT

This work is supported by the National Key Research and Development Program of China with grant number 2018YFB2100501, the Key Research and Development Program of Yunnan province in China with grant number 2018IB023, the National Natural Science Foundation of China with grant number 42090012, 41771452, 417771454.

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