DETERMINATION OF THE ACTUAL LAND USE PATTERN USING UNMANNED AERIAL VEHICLES AND MULTISPECTRAL CAMERA

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ABSTRACT:

The international initiatives developed in the context of combating global warming are based on the monitoring of Land Use, Land Use Changes, and Forests (LULUCEF). Determination of changes in land use patterns is used to determine the effects of greenhouse gas emissions and to reduce adverse effects in subsequent processes. This process, which requires the investigation and control of quite large areas, has undoubtedly increased the importance of technological tools and equipment. The use of carrier platforms and commercially cheaper various sensors have become widespread. In this study, multispectral camera was used to determine the land use pattern with high sensitivity. Unmanned aerial flights were carried out in the research fields of Kahramanmaras Sutcu Imam University campus area. Unmanned aerial vehicle (UAV) (multi-propeller hexacopter) was used as a carrier platform for aerial photographs. Within the scope of this study, multispectral cameras were used to determine the land use pattern with high sensitivity.

1. INTRODUCTION

Remote sensing and geographic information system (GIS) are intensively used tools in both scientific and practical works. Technological developments provide remote sensing techniques with the most cost-effective data production with natural sciences (forestry, agriculture, etc.) and different disciplines. Low-altitude unmanned aerial vehicles provide significant opportunities in high-resolution analyzes to monitor rapid changes in land use (Hunt et al., 2010; Kooistra et al., 2014). The RGB images obtained with these tools also provide the possibility to produce orthophotos where land cover, soil erosion and terrain topographical information can be obtained (d'Oleire-Oltmanns et al., 2012; Bending et al., 2014; Mancini et al 2013). Such devices are used in mainly biomass and land cover analyzes due to the attached NDVI, lidar, or radar cameras (Hunt et al., 2010; Wallace et al., 2012).

2. MATERIAL AND METHODS

Unmanned aerial flights were carried out in the research fields of Kahramanmaras Sutcu Imam University campus area. Unmanned aerial vehicle (UAV) (multi-propeller hexacopter) was used as a carrier platform for aerial photographs.

Preflight planning with the ground control unit was carried out with the "Mission planner" (Figure 1).

The Multispectral Camera (Tetracam ADC Snap) mounted on UAV is used as a sensor. Taking into consideration of the actual land use, flight safety and the sensor characteristics used, the altitude of the aerial photography was set to 50 m, front (forward) and side overlap rates were fixed as 80% and 60%. Before the flight, the estimated resolution was 3.99 cm and a total of 88 aerial photographs have been planned.

Flight information was transferred to the UAV's PixHawk flight controller. The flight was performed by taking necessary precautions within the flight area. PixelWrench, Photoscan and ArcGIS software were used in the image processing, evaluation and visualization. The duration of the planned flight lasted about 7 minutes in light windy and cloudy weather conditions. Beside A computer was used for image processing with a 2 GB graphics card with an I7 processor. The orthophoto image has been converted to the WGS84 UTM Zone 37 projection using ground control points located according to the PhotoScan user’s Manuel. The raw multispectral images obtained with Tetracam were processed according to the purpose using PixelWrench 2 software (Figure 2a). Raw data were first colored and converted to TIFF format (Figure 2b) for photogrammetric processing (Heinold, 2007; Tetracam, 2017). PhotoScan software was used to obtain orthophoto from aerial photographs produced in NIR / R / G bands. Based on the principle of structure from motion, photographs were initially placed on the flight path and a point cloud was obtained (Figure 3, Photoscan, 2016).

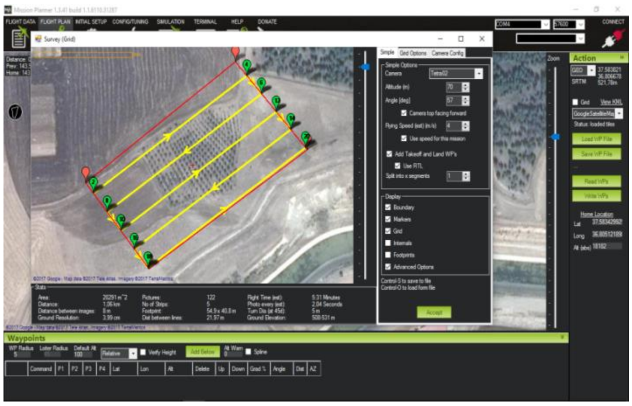

Figure 1. Mission planner software interface (flight planning)

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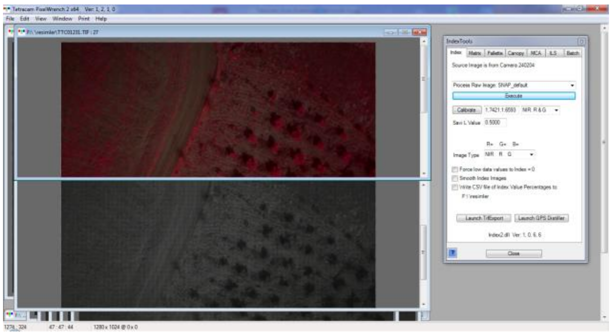

Figure 2a. PixelWrench interface

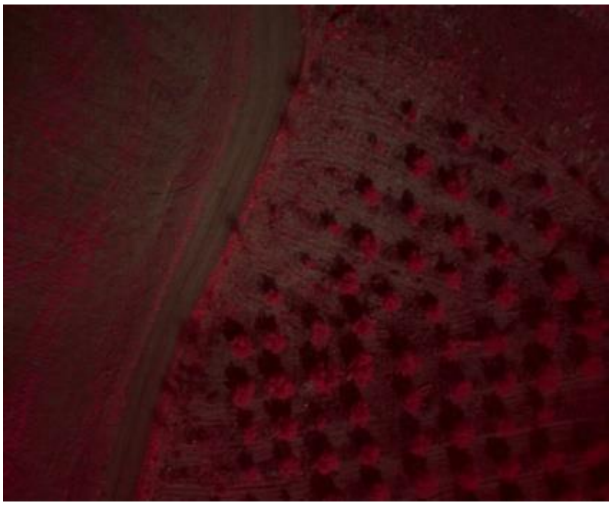

Figure 2b. Generated Tiff image (NIR / R / G)

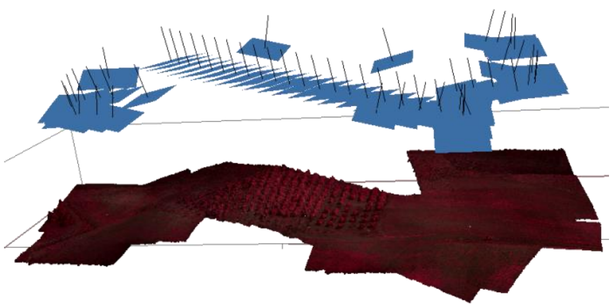

Figure 3. The creation of the photo line with the PhotoScan and the dense of point cloud

3. RESULTS AND FINDINGS

A total of 88 aerial photographs were taken. Total of 57 aerial photographs could be processed and the average flight height was calculated as 53.5 m. Depending on the light and vibration, some photographs were not detected by the program. The resulting RMS error was 0.392 pixels. A computer was used for image processing with a 2 GB graphics card with an I7 processor and about 45 minutes were spent for high quality orthomosaic image production (Figure 4a). The resolution of the produced image was determined to be 3.2 cm / pixel.

. In the geographical coordinate process of the orthophoto image, the total RMS error was 0.09 m. The types of land use were determined from the orthophoto image using the ArcGIS program. NDVI images were classified by using the threshold values of reflection values according to the supervised classification process in ArcGIS program (Figure 4b, ESRI, 2010). NDVI values calculated from multispectral images ranged from -1 to 1.

Six different land covers have been identified by classifying the NDVI values (Figure 5) such as water, soil, vegetation (low, medium and frequent density) and others (shadow, object and unidentified area and man-made objects etc.) (Table 1).

Class value	Class name	Area (m^2)
1	Water	35.67
2	Bare soil	1205.60
3	Low vegetation	4152.43
4	Moderate vegetation	5170.51
5	Dense vegetation	1552.31
6	Others (Undefined)	1351.39
	Total	13467.89

Table 1. Classified land covers based on NDVI

Total of 60 random points were used to determine the classification accuracy (Figure 6). The classification success was 90.74% and the kappa value was 74.9% (Table 2a and 2b).

Class Name	Truth					Rate (%)	Predictions
	1	2	3	4	5		
Bare soil	**3**	0	0	0	0	100	3.0
Low vegetation	2	**18**	0	0	0	90	20.0
Moderate vegetation	1	4	**16**	0	0	76.2	21.0
Dense vegetation	0	0	0	**6**	0	100	6.0
Others	0	2	2	0	**6**	60	10.0
Percent	50.0 %	75.0 %	88.9 %	100.0%	100.0%	90.74%	
Count truth	6	24	18	6	6		60.0

Table 2a. The results of accuracy assessment (Note: Since the water surface area is very small, the control point has not fallen)

Observed Agreement	81.7%
Chance agreement	27.0%
Kappa	74.9%

Table 2b. Cohen's kappa statistic

The results revealed that the sensors used for mapping the actual land uses increased the success with the high-intensity UAV. Thus, three bands (NIR / Red / Green) generated from the multispectral cameras have been useful in identifying the land use differences with higher accuracy.

Aerial photographs from low altitude UAVs and multispectral cameras are one of the important tools in sensitively determining changes in land use. Flight time, flight speed and altitude, lighting status and stable flight position have been found to be very important for obtaining high quality photographic products. The use of UAV- based studies are to give opportunities to obtain high quality photometric data as well as time and cost advantages than other expensive technologies (LIDAR, Satellite Images etc.).

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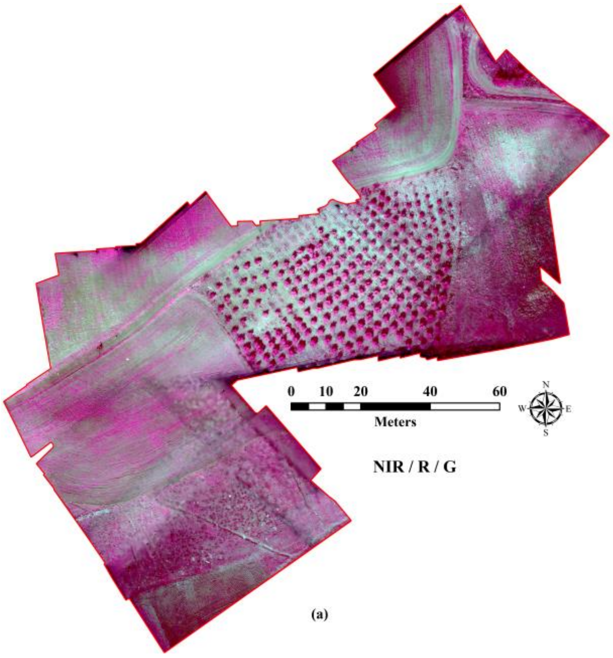

Figure 4a. Generated orthophoto image

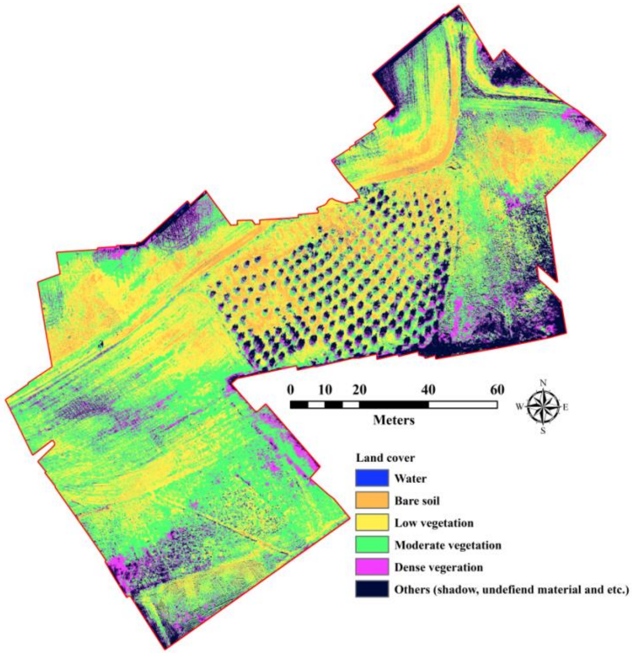

Figure 5. Classified NDVI image

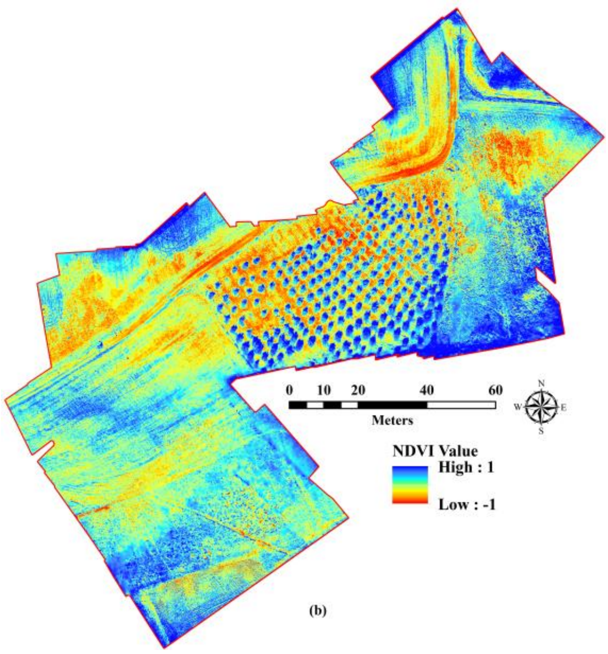

Figure 4b. NDVI image

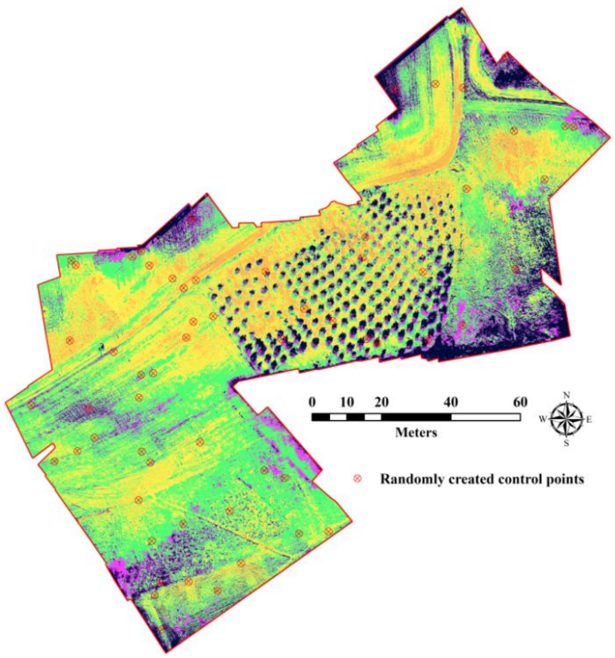

Figure 6. Positional distribution of location control points.

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REFERENCES

Bending, J., Andreas B., Simon B., Janis B., Silas E., and Georg B., 2014. Estimating Biomass of Barley Using Crop Surface Models (CSMs) Derived from UAV-Based RGB Imaging, *Remote Sens*.6, pp. 10395-1041.

d'Oleire-Oltmanns, S., Irene, M., Klaus D.P., Johannes B. R., 2012. Unmanned Aerial Vehicle (UAV) for Monitoring Soil Erosion in Morocco. *Remote Sens.* 4, pp. 3390-3416.

Heinold, S., 2007. Tetracam Multi Camera Array (MCA) Installation and Operation.

Kooistra, L., Suomalainen, J., Iqbal, S., Franke, J., Wenting, P., Bartholomeus, H., Mücher, Becker, S.R., 2013. Workshop on UAV-based Remote Sensing Methods for Monitoring Vegetation. 9th -10th September 2013, University of Cologne, Germany.

ESRI, 2010. ArcInfo user's guide.

Photoscan, 2006. Agisoftsoftwarefromhttp://www.agisoft.com

Hunt, E.R.,Jr., Hively, W.D., Fujikawa, S.J., Linden, D.S., Daughtry, C.S.T., McCarty, G.W., 2010. Acquisition of NIR-Green-Blue Digital Photographs from Unmanned Aircraft for Crop Monitoring. *Remote Sens*. 2, pp. 290-305

Tetracam, 2016. PixelWrench2 User Guide. Tetracam Inc.

Wallace, L., Arko, L., Christopher, W., Darren, T., 2012. Development of a UAV-LiDAR System with Application to Forest Inventory. *Remote Sens*. 4, pp. 1519-154

Mancini, F., Dubbini, M., Gattelli, M., Stecchi, F., Fabbri, S., Gabbianelli, G., 2013. Using Unmanned Aerial Vehicles (UAV) for High-Resolution Reconstruction of Topography: The Structure from Motion Approach on Coastal Environments. *Remote Sensing*, 5(12), pp. 6880-6898.

https://doi.org/10.5194/isprs-archives-XLII-4-W6-39-2017