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An investigation of Triangular Greenness Index performance in vegetation detection

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ABSTRACT

Vegetation is one of the most important elements of environment. With the use of satellite systems and especially multispectral images including NIR wavelength, vegetation-oriented studies have increased intensely. With today's advancing technology, besides satellite systems, the unmanned aerial vehicles (UAV) systems are also used to generate similar spectral information being as a platform. However, there are mostly RGB sensors rather than NIR band sensors. More intensive use of RGB sensors has led to the need to use these data in vegetation research. The visible region vegetation index called Triangular Greenness Index (TGI) in the literature is one of the indexes arising from this need. In this study, aerial photographs of an orchard were obtained by the UAV and an orthophoto was produced. Then, the trees detection performance of the TGI in the orchard was compared with the reference data. As a result, the TGI approach can be able to obtain trees with a 95% rate of producer accuracy. This index provides significant support for plant detection studies in the absence of NIR data.

1. INTRODUCTION

With the recent use of unmanned aerial vehicles (UAV) in civilian areas, new opportunities have emerged in many disciplines. Today UAVs are used in many areas such as agriculture, firefighting, transportation, natural life surveillance, aerial shooting, post-earthquake damage and radiation detection. The use of UAVs in agriculture are generally passive applications for disease and pest detection, water stress detection, yield and maturity estimation, weed flora detection, water resources control and monitoring of workers based on remote sensing and plant monitoring techniques that will constitute the infrastructure of data to be used in precision agriculture. The use of unmanned aerial vehicles for agricultural purposes is extremely important, especially in terms of sustainable and sensitive agricultural practices. In terms of agriculture, UAVs can be used in many different areas such as control of water resources, product observation, equipment and building observation, mapping, yield control, soil erosion, water stress, disease, pest and weed detection and control (Türkseven 2016; Özgüven 2018 ; Şin and Kadıoğlu 2019). For this, different featured cameras are used, and it becomes possible to fight these weeds (Bannari et al. 1995). The data to be obtained from the UAVs mounted cameras can be passed through different processes and the existing flora can be mapped (Özgüven 2018), and the product losses that may occur are calculated. Due to the sensitivity of green plants to infrared wavelengths, NDVI and similar studies are carried out (Türkseven et al. 2018). However, visible region indexes are also available in the scientific literature. In this study, an orchard was observed by producing the Triangular Greenness Index (TGI) from UAV based RGB orthophoto.

2. METHOD

2.1. Study Area and Equipment

The study was held in orchards located in the northern part of the Harran University Osmanbey Campus (Figure 1). A 22 minutes flight was carried out with TurkUAV Octo V3 automatically depending on the flight plan. The flight plan was prepared as 6 columns from 60 m height. The Sony RX100 camera (20.2 Megapixel CMOS sensor) was mounted to UAV and 223 geotagged images were taken.

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Figure 1. Study area in Harran University Osmanbey Campus (Rectangle site)

2.2. Triangular Greenness Index (TGI)

Today, spectral information is very important for agriculture in both separating vegetation and deeper examination of vegetation. Generally, these studies are based on spectral indices which are generated either calculating band ratios or normalizing band differences (Jackson and Huete 1991). Most of this index uses NIR wavelengths which is sensitive to both chlorophyll content and leaf area index (LAI). Haboudane et al. (2008) suggested the triangular chlorophyll index based on green, red and red-edge bands to detect leaf nitrogen amount. Later, red-edge bands are used on many satellite sensors (Eitel et al. 2007; Herrmann et al. 2011; Ramoelo et al. 2012) and this increase the sensitivity to chlorophyll detection (Gitelson 2012). However, NIR or red-edge bands are generally not available on low-cost multispectral sensors, which have only at visible wavelengths bands; therefore, a visible-band index called the triangular greenness index (TGI) was developed (Hunt et al. 2011). The proposed method is depending on the chlorophyll content.

TGI: $0.5(120(Red - Green) - 200(Red - Blue)$ **(1)**

Within the scope of the study, TGI image was divided into two classes as the vegetation and the other. For this, the color slicing method was applied. Color Slicing process assigns the same colors to the pixels with similar values in a user decided values range (Harris Geospatial 2016). This tool, which is available in many commercial and open source software, provides ease of visual perception of data and the possibility to obtain the desired color class in vector format. This step is applied for to calculate accuracy of detection rate of trees. Green vegetation such as grass in the study area were visually monitored by orthophoto overlay analysis. However, a metric accuracy analysis was also made with reference data of the trees in the region.

$$\textbf{Producer Accuracy (PA):} \frac{TP}{TP+FN} \quad (2)$$

$$\textbf{User Accuracy (UA):} \frac{TP}{TP+FP} \quad (3)$$

$$\textbf{Quality (Q):} \frac{TP}{TP+FN+FP} \quad (4)$$

Where TP is true positive, FP is false positive, and FN is false negative values of detected trees with respect to reference data.

3. RESULTS

Within the scope of the study, an UAV flight was performed. The flight is planned as 70% overlap from 60 m height. A total of 223 suitable geotagged images were selected and processed. The GSD value calculated for the study is 1.28 cm/pix and 2 521 581 features are matched and 162 085 970 3D points belonging to the study area were obtained. The camera locations, image overlaps and generated orthophoto can be seen in Figure 2.

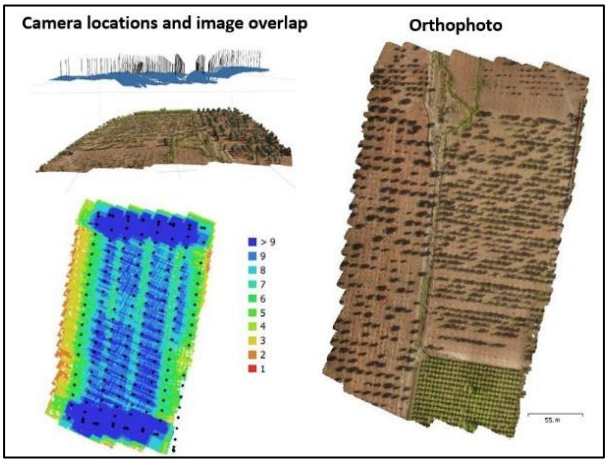

Figure 2. Camera locations, Image overlaps and Orthophoto

In the next part of the study is the TGI generation. This step is performed with band math tool in Envi software in accordance with the given equation 1. Then the color slice is applied to generated TGI image. TGI, color slice and color slice overlaid orthophoto can be seen in Figure 3.

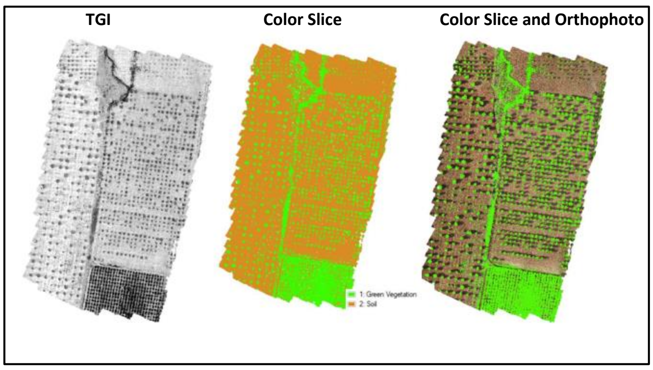

Figure 3. TGI, color slice and color slice overlaid Orthophoto

As seen in Figure 3, the TGI result has an obvious match over vegetation area. The trees and grassland are successfully detected. To get a metric comparison about TGI performance, an accuracy assessment is performed according to equations 2, 3, and 4. A reference shape file of trees is used to make the calculations (Figure4).

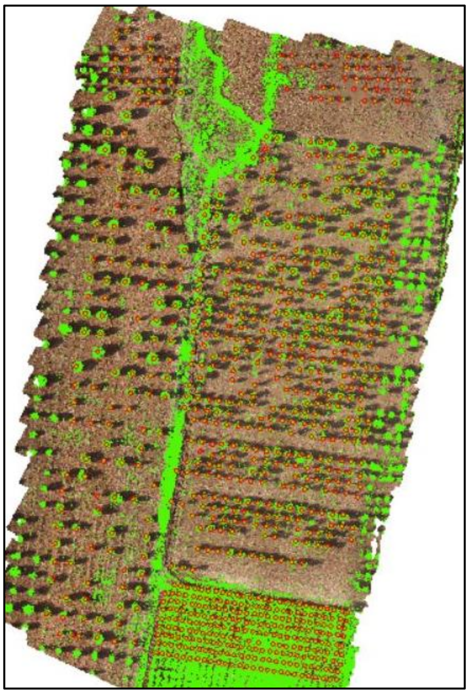

Figure 4. TGI vegetation class and reference tree overlaid to Orthophoto

As seen in figure 4, the vegetation areas have good match with reference trees (red circles). The calculations are performed manually counting but grassland was ignored in this calculation. The calculating results can be seen in Table 1.

Table1. Accuracy analysis

Producer Accuracy (%)	95
User Accuracy (%)	98
Quality (%)	94

The high User Accuracy means that the areas classified as green vegetation are indeed green vegetation. The lower Quality value is that some saplings that appear as trees in the reference data could not be detected. Since TGI is sensitive to green color / chlorophyll, these saplings without green leaves have not been detected yet and the accuracy has been reduced.

CONCLUSION

Vegetation indexes are digital images that are being used in many applications. These indexes, which are mostly obtained by using the NIR and Red bands of the satellite images, provide information about the vegetation existence with high accuracy. However, it is possible to obtain vegetation index with standard digital cameras without NIR data. In this study, TGI was produced and its performance in detecting green vegetation areas was evaluated. The TGI produced over the orthophoto generated from the aerial photographs taken with the UAV and the result of the TGI was compared with the reference data by considering only the trees. As a result, green vegetation areas were obtained with 94% of quality value.

REFERENCES

Bannari A, Morin D, Bonn F, and Huete A R (1995). A Review of Vegetation Indices. Remote Sensing Reviews, 13: 1, 95- 120

Eitel J U H, Long D S, Gessler P E, Smith A M S, (2007). Using in situ measurements to evaluate the new RapidEyeTM satellite series for prediction of wheat nitrogen status. International Journal of Remote Sensing 28, 4183–4190.

Gitelson A A (2012). Nondestructive estimation of foliar pigment (chlorophylls, carotenoids, and anthocyanins) contents: evaluating a semianalytical three band model. In: Thenkabail P S, Lyon J G, Huete A (Eds.). Hyperspectral Remote Sensing of Vegetation. CRC Press, Boca Raton, FL, pp. 141–165.

Haboudane D, Tremblay N, Miller J R, Vigneault P (2008). Remote estimation of crop chlorophyll content using spectral indices derived from hyperspectral data. IEEE Transactions of Geoscience and Remote Sensing 46, 423–437.

Harris Geospatial. (2016). Raster Color Slices. https://www.harrisgeospatial.com/docs/ColorSlices.html. Accessed 24 September 2020

Herrmann I, Pimstein A, Karnieli A, Cohen Y, Alchanatis V, Bonfil D J (2011). LAI assessment of wheat and potato crops by VENS and Sentinel-2 bands. Remote Sensing of Environment 115, 2141–2151

Hunt E R, Daughtry C S T, Eitel J U H, Long D S, (2011). Remote sensing leaf chlorophyll content using a visible band index. Agronomy Journal 103, 1090–1099

Jackson R D, Huete A R (1991). Interpreting vegetation indices. Preventive Veterinary Medicine 11, 185–200.

Ramoelo A, Skidmore A K, Cho M A, Schlerf M, Mathieu R, Heitkönig I M A, (2012). Regional estimation of savanna grass nitrogen using the red-edge band of the spaceborne RapidEye sensor. International Journal of Applied Earth Observation and Geoinformation 19, 151–162.

Şin B, Kadıoğlu İ (2019) İnsansız Hava Aracı (İHA) ve görüntü işleme teknikleri kullanılarak yabancı ot tespitinin yapılması. Turkish Journal of Weed Science 20(2):211-217

Türkseven S, Kızmaz M Z, Tekin A B, Urkan E, Serim A T (2016). Tarımda dijital dönüşüm, insansız hava araçlarının kullanılması. Tarım makinaları bilim dergisi, 12 (4), 267-271.

Türkseven S, Tekin B, Kızmaz M Z, Urkan E., Serim A T (2018). İnsansız hava araçları ile pamukta yabancı ot florasının tespit edilme olanakları. Türkiye VII. Bitki Koruma Kongresi (Uluslararası Katılımlı), 14-17 Kasım 2018, Muğla Türkiye

Özgüven M M (2018). Hassas Tarım. Akfon kitap kırtasiye, 334s. Ankara. ISBN: 978-605-68762-4-0