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Classifying unmanned aerial vehicle images for urban vegetation mapping utilizing SVM

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Abstract

This study focuses on the potential of sUAVs for mapping urban vegetation. The researchers compared the effectiveness of maximum likelihood and SVM algorithms for classification purposes. Additionally, they tested different window sizes to determine the optimal size for calculating textural indices. An ortho-mosaic image was used to analyze the vegetation. A total of 748 images were collected from a height of 100 meters using a low-cost UAV, resulting in a resolution of 2.56 cm per pixel. To ensure accurate results, a high overlap of 90% forward and 80% side overlap was maintained to minimize vegetation masking by tall buildings. Ground control points were collected using GPS RTK technology, and all images were processed using Agisoft PhotoScan v1.27 software with a root mean square error of 0.2 pixels. Eight textural indices, including mean, standard deviation, homogeneity, contrast, dissimilarity, entropy, correlation, and angular second moment were extracted using gray-level co-occurrence matrix (GLCM). These texture indices were calculated using six different window sizes ranging from 3×3 to 45×45. The findings of this study will contribute to the understanding of sUAV-based remote sensing for mapping urban vegetation and provide insights into the most effective classification algorithms and window sizes for calculating textural indices.

1. Introduction

Today, the importance of information is hidden to no one so that the present age can be called the information age, the computer is the symbol of the age, the information is the symbol of wealth and knowledge is the basis of power. Its importance comes from the need for information to make any planning and decision-making.

As a rapidly evolving technology, small unmanned aerial vehicle (sUAV) based remote sensing has received many attentions from researchers and managers recently (Smith et al. 2002; Rasmussen et al. 2016). sUAV is an innovative and flexible technology which is able to collect very high resolution images for both geometric and descriptive purposes (Rasmussen et al. 2016). UAVs collected images offers a unique way to obtain large scale mapping of vegetation cover as well as vegetation canopy attributes (Gini et al. 2012).

From many prospects, urban vegetation plays important roles such as decreasing heat island effect (Chianucci et al. 2016), increasing air quality, reducing sound noises, and promoting quality of life (Fan et al. 2015). Managing and planning urban vegetation establishment and development need accurate timely large-scale spatial data. For many years space born data has been utilized to delineate urban vegetation. However, complex residential area needs high resolution images. Such images aren't usually available and airborne imagery aren't a cost-efficient method. However, sUAV imagery offers a great potential for collecting hyper resolution images with affordable price.

UAV images have been utilized for studying different vegetation aspects such as tree species identification (Miraki and Azizi, 2022), vegetation phenology (Miraki et al., 2021), tree height estimation (Panagiotidis et al, 2017; Sadeghi and Sohrabi, 2019), composition and abundance (Azizi and Miraki, 2021), and etc. Results of these studies showed that using UAV images is highly competitor to other data sources. Despite this, one of the most important drawbacks of such data is low spectral resolution which makes it difficult to delineate vegetation cover using RGB data. In RGB space, it is difficult to separate vegetating from other land classes. Another drawback is shadow which can highly affect the

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result of vegetation mapping in residential areas especially where there are many tall buildings.

One solution is to use texture indices instead of spectral data. Some researchers reported better results for estimation of vegetation attributes using textural indices rather than spectral data or indices (Safari and Sohrabi, 2016). However, there are few studied on textural indices derived from very high resolution (VHR) images for urban vegetation mapping. Fan et al (2015) used random forest and textural indices to map the vegetation of an urban area. They concluded that UAV is an efficient and idea platform for mapping urban vegetation.

The aim of this study is to assess the potential of sUAV images for mapping urban vegetation. For classification, we compared maximum likelihood and support vector machine. Also, we tested different window size for calculating textural indices to find the best window.

2. Method

The location of the study area (Karaj City, Alborz Province) and part of the ortho-mosaic is shown in figure1.

For aim of this study, 748 images were collected from 100 meter above sea level using a low-cost UAV resulting in resolution of 2.56 cm per pixel. The forward and side overlap were 90% and 80%, respectively.

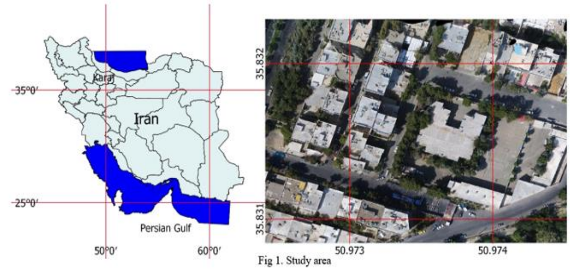

Fig 1. Study area

We considered high overlap to avoid vegetation masking by tall building as much as possible. Using GPS RTK, 24 ground control point has been collected. All images were processes in Agisoft PhotoScan v1.27 with a root mean square error of 0.2 pixel. Based on gray-level co-occurrence matrix (GLCM), eight textural indices including mean (MEA), standard deviation (STD), homogeneity (HOM), contrast (CON), dissimilarity (DIS), entropy (ENT), correlation (COR), and angular second moment (ASM) were extracted. Texture indices were calculated using six different window sizes including 3×3, 9×9, 21×21, 31×31, and 45×45 (Sohrabi et al. 2010).

3. Results

Two frequently used algorithm for classification are random forest (RF) and support vector machine (SVM). However it has been reported by some researchers that SVM performs better than RF (Safari et al. 2017; Piragnolo et al. 2017; Azizi and Miraki, 2022). For classification, we used algorithm. Also, to compare the result of SVM, we used maximum likelihood (ML) classification as well. Three classes were considered including roof, asphalt, and vegetation. Training samples of different classes were randomly chosen in a small polygon block. To assess the accuracy of classification, confusion matrix was used from independent validation samples and Kappa index, overall accuracy (OA), producer accuracy (PA) and user accuracy (UA) were calculated (Figure 2).

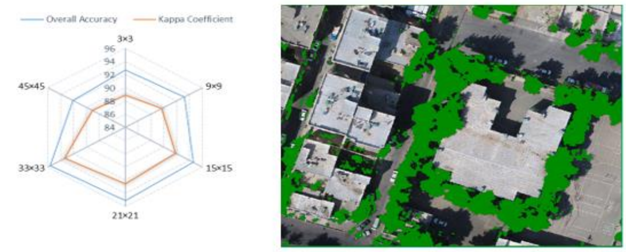

Fig 2. Overall accuracy and Kappa coefficient for different window sizes (left) and classification result (right)

4. Discussion

Results showed that for any window size, SVM resulted better accuracy in comparing to ML algorithm. Also, by increasing the window size for deriving the texture indices the accuracy of classification was increased. But after 31×31 there were rapid decrease in the accuracy of the classification. The best result was for 31×31 by kappa coefficient of 93.4% and overall accuracy of 95.6%. From a visual inspection, using texture with 31×31 windows for classification decreased the drawback of "salt and pepper" effects which is a common problem in spectral based classification.

The smaller the window size, the higher the salt and pepper effect. Also, this problem was higher for ML results. Fan et al. (2015) and Azizi and Miraki (2022) found the same result for comparing ML and RF. Surprisingly, they also reported 31×31 window size as the best window size.

5. Conclusion

The result of accuracy assessment showed that the UAV images and SVM classification can result in green space maps with high accuracy.

Momeni et al. (2016) reported 91% for mapping complex urban land cover from spaceborne imagery. Feng et al. reported 90% accuracy for urban vegetation mapping using random forest and texture analysis. Based on the result using UAV images with the current approach (classifying image texture using SVM) is a promising solution to depict vegetation maps in complex urban areas.

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