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Pixel based classification of Lavandula sp. using high resolution UAV orthophotos

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Abstract

Lavender, a member of the Lamiaceae family, is a notable plant known for its production of volatile oil. Lavender oil is prized for its antiseptic and antibiotic qualities, as well as its unique aromatic properties, making it a valuable resource in aromatherapy practices. Consequently, closely monitoring lavender plants has become a significant concern. Unmanned Aerial Vehicles (UAVs) offer a valuable solution for this task by providing high-resolution imagery through low-altitude flights and advanced digital cameras. In this study, UAVs were utilized to create orthophotos of a lavender garden. Orthophotos are meticulously corrected aerial images, ensuring consistent scale and distortion-free representation, which makes them ideal for various analytical purposes. The primary objective of the study is pixel based classification of lavender. To enhance lavender plant monitoring, machine learning techniques, specifically Support Vector Machines (SVM) and K-means clustering, were employed for binary classification. These methods were applied to analyze the orthophotos generated by the UAVs, likely to classify different sections or features within the lavender garden. In conclusion SVM provided a higher overall accuracy value for the classification results at both 1 cm and 10 cm resolutions.

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Introduction

Lavender *(Lavandula sp.*), belonging to the Lamiaceae family, is a significant volatile oil-producing plant. In Turkey, various lavender species exhibit variations in the composition of their essential oil constituents, influenced by factors including species differentiation, climatic conditions, genetic attributes, harvesting and processing methodologies, among others. Furthermore, lavender oil finds application in aromatherapy practices owing to its antiseptic and antibiotic attributes, as well as its distinctive volatile oil characteristics [1].

In the province of Isparta, when calculating the Internal Rate of Return (IRR) for lavender cultivation currently underway, both fresh and dried lavender have been considered. The IRR is calculated at 22.59% for fresh lavender and 29.24% for dried lavender [2].

In the past decade, Unmanned Aerial Vehicles (UAVs) have gained widespread use in engineering projects, spanning diverse applications such as forest fire risk assessment, landslide monitoring, and cultural heritage modeling studies. One of UAV deployment's most compelling advantages is its ability to capture high spatial resolution imagery due to low-altitude flight and advanced digital cameras[3-5].UAVs also find utility in detecting vegetation areas, assessing their condition, and monitoring reforestation efforts. The high-resolution image data obtained from UAVs is utilized to extract essential information for vegetation research using various image processing techniques [6-8]. Importantly, temporal variations in UAV-captured images, acquired at specific intervals, can be revealed through image processing, serving as valuable evidence and a basis for early detection and cost-effective interventions in Lavender cultivation areas [9].

The Lavender plant, which has commercial value and finds applications in aromatic and medical domains, has been cultivated for such purposes at Harran University's Osmanbey Campus. Within the scope of this study, UAV-based orthophotos were generated for the Lavender garden planted, and machine learning-based SVM and k-means methods were employed for binary classification with the aim of monitoring the plant's growth progress.

Material and Method

Study Area

The study area depicted with red polygon is located in the Harran University's Osmanbey Campus on a gently sloping terrain (Figure 1). This area predominantly hosts olive and pomegranate trees, covering a span of 0.0212 km^2. To obtain aerial imagery of this region, a photogrammetric flight plan was meticulously crafted. The flight plan involved six columns of imagery captured from a height of 30 meters, ensuring an 80% overlap between images. Using a DJI Mavic 2 Pro drone, a 20-minute flight mission was executed, resulting in a total of 418 geotagged images. After acquiring aerial imagery, we processed the data using Structure-from-Motion (SfM), a cost-efficient and user-friendly photogrammetric method that has gained popularity in recent years [9].

Figure 1. Study area depicted with red polygon in Harran University Osmanbey Campus

Support Vector Machine

Support Vector Machines (SVM) is a machine learning method developed by Vapnik in 1985. It optimizes a hyperplane for maximum class separation, using support vectors as the closest data points. When linear separation isn't possible, SVM employs the kernel trick to project data into a higher-dimensional space. For M-class problems, two approaches exist: One-Against-One generates M binary SVM classifiers, while One-Against-All applies SVM to all M choose 2 combinations. SVM finds applications in fields such as classification, prediction, and forecasting [10].

K-Means

The K-means algorithm stands out as one of the most straightforward and widely recognized clustering techniques. Its primary objective is to identify cluster centers and allocate data elements to these clusters by minimizing a squared error-based objective function. The algorithm strives to position cluster centers as far apart from each other as feasible while assigning each data point to its nearest cluster center. Typically, the Euclidean distance metric is employed to measure dissimilarity within the K-means algorithm [11].

Results

Within the scope of the study, the opportunity to produce high-resolution orthophotos from aerial photographs was realized. In this context, orthophotos were generated at two different resolutions (1 cm and 10 cm), and lavender plants were detected through classification using both K-Means and SVM methods. The obtained results are presented in Figure 2.

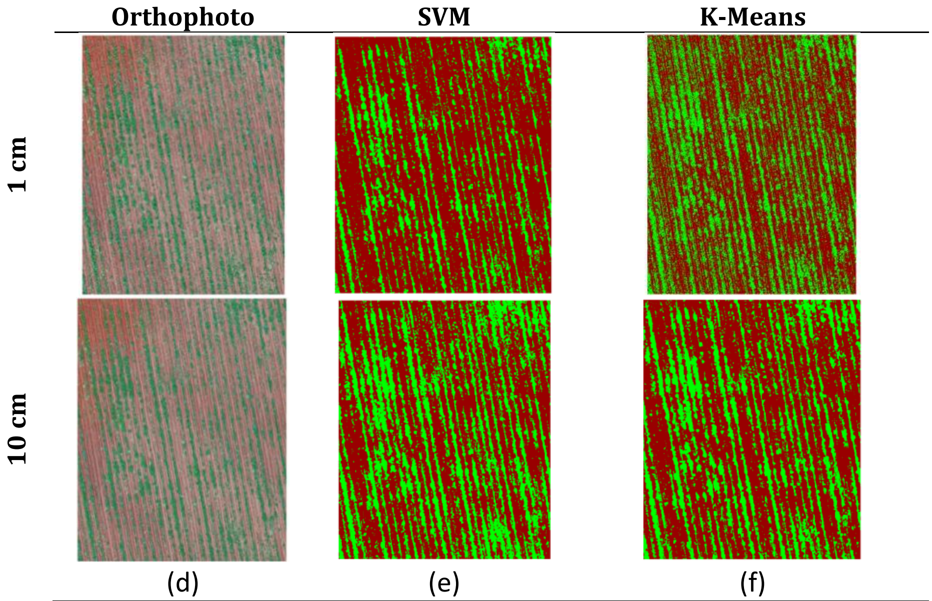

Figure 2. 1 cm and 10 cm orthophotos and classification results

As part of the study, accuracy analysis was conducted on the result images using ground truth regions of interest (ROI*s*) for post-classification accuracy assessment. The overall accuracy, kappa value, producer's accuracy, and user's accuracy values obtained from this analysis are presented in Table 1.

Table 1. Accuracy metrics

Methods	Global Accuracy	Producer Accuracy.	User Accuracy	Kappa
SVM 1cm	99.97	99.97	100.0	0.99
SVM 10 cm	99.68	100.00	99.39	0.99
K means 1 cm	88.82	90.35	89.25	0.77
K means 10 cm	90.71	78.05	99.96	0.80

Discussion

In visual assessment, the SVM classification result image exhibits higher resolution, appearing smoother and more comprehensible at 1 cm resolution, whereas at 10 cm resolution, it appears more complex with increased ambiguity in the delineation of planting lines. In the K-means results, the 10 cm result is smoother. According to Table 1, SVM provided a higher overall accuracy value for the classification results at both 1 cm and 10 cm resolutions. The lowest producer's accuracy was achieved in the 10 cm K-means image. The highest user's accuracy, on the other hand, was obtained with the 1 cm SVM classification.

Conclusion

In this study, machine learning methods, namely SVM and K-means, were used to classify images with high spatial resolutions of 1 and 10 cm, based on UAV data. It has been observed that the SVM-controlled classification method yielded better results compared to k-means unsupervised classification.

References

1. Varli, M., Hanci, H., & Kalafat, G. (2020). Tıbbi ve aromatik bitkilerin üretim potansiyeli ve biyoyararlılığı. Research Journal of Biomedical and Biotechnology, 1(1), 24-32.
2. Güler, K. H., & Korkmaz, M. (2018). Isparta ili orman köylerinde lavanta yetiştiriciliğinin ekonomik analizi. Turkish Journal of Forestry, 19(2), 156-162. https://doi.org/10.18182/tjf.424901
3. Kabadayı, A. & Erdoğan, A. (2023). İHA Fotogrametrisi Kullanarak Yozgat Çilekçi Türbesi'nin 3 Boyutlu Nokta Bulutu ve Modelinin Üretilmesi. Türkiye Fotogrametri Dergisi, 5 (1), 29-35. https://doi.org/10.53030/tufod.1313200
4. Yakar, M., Murat Yilmaz, H., Yildiz, F., Zeybek, M., Şentürk, H., & Çelik, H. (2009). Silifke-Mersin Bölgesinde Roma Dönemi Eserlerinin 3 Boyutlu Modelleme Çalışması ve Animasyonu. Jeodezi ve Jeoinformasyon Dergisi, 101.
5. Alptekin, A., Çelik, M. Ö., Doğan, Y., & Yakar, M. (2019). Mapping of a rockfall site with an unmanned aerial vehicle. Mersin Photogrammetry Journal, 1(1), 12-16.

6. Alptekin, A., & Yakar, M. (2020). Determination of pond volume with using an unmanned aerial vehicle. Mersin Photogrammetry Journal, 2(2), 59-63.
7. Polat, N., Memduhoğlu, A., & Akça,Ş. (2022). Determining the change in burnt forest areas with UAV: The example of Osmanbey campus. Advanced UAV, 2(1), 11-16.
8. Khrulev, A. (2023). Analysis of pneumatic catapult launch system parameters, taking into account engine and UAV characteristics. Advanced UAV, 3(1), 10-24.
9. Akca, S., & Polat, N. (2022). Semantic segmentation and quantification of trees in an orchard using UAV orthophoto. Earth Science Informatics, 15(4), 2265-2274. https://doi.org/10.1007/s12145-022-00871-y
10. Akca, S., & Gungor, O. (2022). Semantic segmentation of soil salinity using in-situ EC measurements and deep learning based U-NET architecture. Catena, 218, 106529. https://doi.org/10.1016/j.catena.2022.106529
11. Orhan, U., Hekim, M., & Ozer, M. (2011). EEG signals classification using the K-means clustering and a multilayer perceptron neural network model. Expert Systems with Applications, 38(10), 13475-13481. https://doi.org/10.1016/j.eswa.2011.04.149