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The effect of segmentation parameters on extracting the crown area of Tehran pine trees (Pinus eldarica)

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Abstract

Man_made forests have been created with ecological goals such as preserving water and soil resources and economic goals such as wood production. These forests help reduce pressure on natural forests. Therefore, knowledge of the state of quantitative and qualitative features of the forest has always been of interest to the managers of these types of forests and to help them in future planning and achieving primary goals. The purpose of this research is to compare the crown area of Eldarica pine trees in Pardisan Park, North Khorasan province with the change of density parameters in stages 0.1, 0.3, 0.5, 0.7, 0.9, 1 , scale in stages 0.1,0.5,0.7,0.9 and Shape in stages 25, 50, 100 ,150. The results showed that the change in each of the parameters brings different results in the estimation of the tree's crown surface. Also, the results showed that the best result was obtained in (density=0.5, scale=25, shape=0.1) and the worst result in (shape=0.9, compactness=0.1, scale=150).

1. Introduction

Each of the physical parameters of trees in forests is important for careful monitoring and management. Accurate and efficient measurement of single tree parameters is the basis of man-made forest resource monitoring (Husingolizadeh et al., 2023). With the rapid development of remote sensing technology, it has become possible to obtain information on vast forests and monitor the growth and determine the physical parameters of forest trees with greater speed and efficiency. Remote sensing captures a complete image in its viewing angle by recording the landscape. Therefore, every visible feature, including the position of the complication and the position relative to other complications, is provided for the user. Depending on the conditions and purpose, this complete image can be used together with in_situ measurements to create a valuable perspective on solving some issues on aspects of forest management (Hassingolizadeh et al., 2023). Also, with access to remote sensing data, a wide range of spatial and temporal scales are often available to users. In addition, massive data archives allow us to explore more forest issues from the past to the present (Zhu et al., 2018). Remote sensing images have a high degree of homogeneity and collect data in relatively stable conditions without human intervention in coniferous forests (Duarte et al., 2020). Although the study of forest and trees using remote sensing techniques is considered one of the active areas for research, some physical parameters at the single tree level are problematic (Onishi and Lse., 2021).

With all the capabilities of remote sensing in the forests, sometimes satellite remote sensing cannot observe with proper accuracy due to technical limitations. One of the most important of these limitations and obstacles is the lack of timely data collection in the target areas (Zhang and Jim, 2013). Among them, it can be mentioned that satellite data with medium or low resolution is not suitable for many research fields (Tang and Shao, 2015). On the other hand, height measurement, diameter at breast height and precise measurement of tree crown dimensions are considered as basic physical quantities in forest management (Bukalo et al., 2013).

Despite the valuable research that has been done in the past (Ahmad et al., 2021), so far, no study has been conducted to investigate the effect of segmentation parameters. In this research, the scale parameter is determined to determine the existing objects based on the homogeneity or heterogeneity of the area.

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2. Method

2.1. Study area

Pardisan Park of North Khorasan is located at the eighth kilometer of Bojnord-Mashhad road (37° 28 ' 57 N "-57° 25 ' 49 " E, Zone 40 N), at an average altitude of 1080 meters above sea level. This complex is purely covered with Tehran pine (Pinus eldarica). The region is cold semi-arid according to the coupon criteria and has a relatively high slope in terms of topography (altitude range 1112 to 1037 meters). The average rainfall and its temperature according to the statistics of Bojnurd Airport Meteorological Synoptic Station (the closest station to the study area) for a period of 10 years (2011-2021) are 260 mm and 15 ° C, respectively.

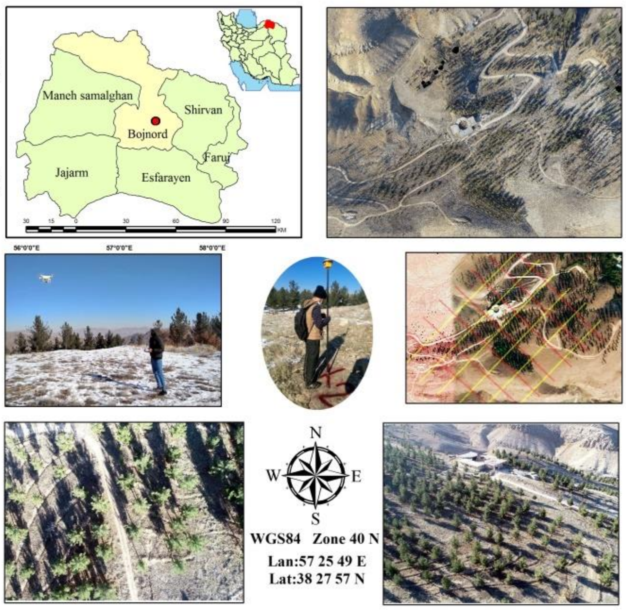

Figure 1. IRAN and Pardisan park

2.2. Research method

In this study, a Phantom 4 Pro was used for the image collection. In the first stage, the planning and design of the flight route was done by visiting the local area and obtaining the necessary permits. In the selection of the flight path, due to the decrease in the number of flight paths and selection of areas with less movement of drone, the design with a longer flight path was considered. In choosing the right day and time of flight, was also considered to control the weather conditions, especially the wind speed of less than one knot.

In order to prevent the stretching of the image and the effect of the intense light of the horizon, the parameters affecting the images, including the opening angle (Field of View<500) and the overall speed of the drone (4 m/s) were adjusted. Before the flight operation, 14 ground control points were established with proper distribution in the area. Then, according to the ups and downs of the ground and control of other effects in the area from a height of 40 meters and the longitudinal and transverse coverage of 80 and 40 percent, flight operations were carried out to receive RGB images. During the entire flight operation, by keeping the bird's balance sensor active (Tilt Sensor<50), taking pictures with a high tilt angle was prevented. In the next step, the images were processed. At this stage, by performing the necessary preprocessing, the three-dimensional model of the Eldarica pine trees of the region was obtained. Then, the images were processed by changing and dividing the parameters including Compactness, Scale Parameter and Shape in Ecognition V9.1. By changing each of the stated parameters, different areas for the tree crown were obtained, which were compared with in situ measurements. Figure 1 shows the location of the research and Figure 2 shows its steps.

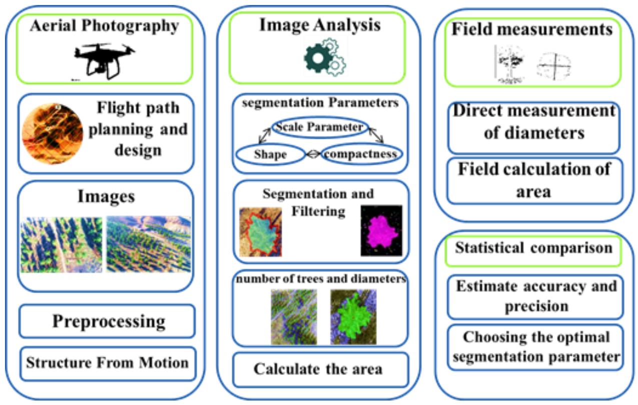

Figure 2. The general steps used to of conduct this research

3. Result

Pine trees with different crown areas were directly measured in the field and photographed by UAV. The field measurements summarized in the study area shown in Table 1.

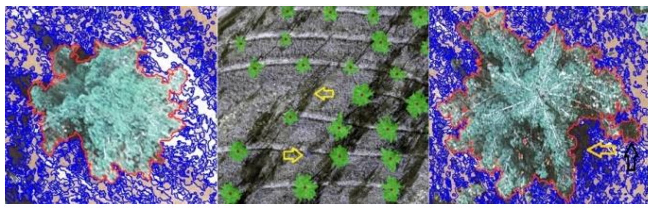

Figure 3. Right side image (black arrow: wrong detection of the shadow instead of the crown, orange arrow: correct detection of the shadow and removing it from the crown area) The middle image (removing the shadow effect and correctly identifying the area of the crown in the top view). The image on the left (a sample of the crown of a tree with the correct recognition of the crown)

The shadow effect misrecognizing a tree crown or not recognizing the real area of the crown (the part that is actually part of the crown area) (Figure 3), the amount of the area has undergone major changes. To solve this problem, the use of cloud points with a suitable filter and imaging at noon (due to the shorter shadow) can partially solve the effect of wrong detection. In Table 1, the red highlight shows the worst result and the green highlight shows the best result.

Table 1. The average area of the canopy of Eldarica pine trees in different parameters (numbers are rounded up)

Average measured value (Square meters)	Crown Area	Scale	Shape	Compactness	Crown Area	Scale	Shape	Compactness	Crown Area	Scale	Shape	Compactness
5106	5556	25	0.1	0.5	6050	25	0.1	0.3	5689	25	0.1	0.1
	5571	50			6140	50			5791	50		
	5620	100			6480	100			5824	100		
	5692	150			6524	150			5836	150		
	5580	25	0.5		6011	25	0.5		6148	25	0.5	
	5598	50			6054	50			6231	50		
	6043	100			6147	100			6480	100		
	6152	150			6349	150			6494	150		
	6004	25	0.7		6033	25	0.7		6124	25	0.7	
	6055	50			6078	50			6176	50		
	6101	100			6128	100			6340	100		
	6247	150			6711	150			6399	150		
	6014	25	0.9		6042	25	0.9		6137	25	0.9	
	6038	50			6088	50			6142	50		
	6079	100			6121	100			6189	100		
	6091	150			6139	150			6508	150		
	4300	25	0.1	1	5702	25	0.1	0.9	6010	25	0.1	0.7
	4381	50			5741	50			6043	50		
	4401	100			5768	100			6085	100		
	4410	150			5831	150			6149	150		
	4204	25	0.5		4501	25	0.5		6044	25	0.5	
	4248	50			4583	50			6055	50		
	4306	100			4598	100			6073	100		
	4409	150			4603	150			6097	150		
	3911	25	0.7		4511	25	0.7		6089	25	0.7	
	3949	50			4562	50			6082	50		
	3980	100			4587	100			6105	100		
	4065	150			4650	150			6119	150		
	3799	25	0.9		4304	25	0.9		6102	25	0.9	
	3855	50			4381	50			6109	50		
	3906	100			4409	100			6157	100		
	4351	150			4207	150			6194	150		

3. Discussion

Due to the presence of a major complication in the region (eldarica pine tree), the comparison of the segmentation in different parameters can be done in better conditions. In this research, steps of 0.1, 0.3, 0.5, 0.7, 0.9, and 1 were used for the Compactness parameter, 0.1, 0.5, 0.7, and 9.0 for the Shape parameter, and 25, 50, 100, and 150 for the Scale parameter. After the necessary processes and with the aim of determining the optimal coefficients for Compactness, Scale and Shape parameters, the results were obtained. According to the results of Table (1), the results showed that a change in each segmentation parameter will result in different areas for the crown of the pine tree. Based on all 96 segmentation executions, the best segmentation was obtained for the only class in the image (Elderica pine tree), in parameters Shape=0.1, Scale=25 and Compactness=0.5. While the worst result was obtained with Shape=0.9, Scale=150 and Compactness=0.1 parameters. In general, the worst segmentation results in this research are when the Shape parameter is set to the maximum value of the research, which is 0.9. In other words, in this case, the color of the images has a full effect on the segmentation, which will bring errors in the result. Including the effect of the color of the bush and the grass at the base of the tree, which are close to each other in the projection of the tree crown in the resulting image, which can have a greater effect on the area estimation error. Regarding the Compactness parameter, the worst results are related to the time when the parameter number is at its maximum value = 1Compactness. In fact, in this case, the shape is considered as a curve with the same radius (circle), which is not in harmony with the irregular, unformulated and varied shape of the pine tree crown. This parameter has the greatest possible effect on the segmentation process compared to the other two parameters. Therefore, more care should be taken in selecting coefficients of parameters, especially Compactness. Also, the results of the analysis in Table (1) show that the quality of appropriate segmentation is obtained if the shape and color have a balanced effect on the creation of parts. In other words, the boundary of the parts should not be too high (Compactness=1) or low (Compactness=0.1). Usually Compactness = 0.5 gives better results because all trees have different shapes with different irregularity, 0.5 can create a more balanced overall effect. Therefore, the total crown area can have better effectiveness. Another result that can be obtained by looking at table 1 is that if only one of the parameters (Compactness, Scale, Shape) is changed and the other two are constant, no regular increase or decrease can be seen in the results. In addition, by increasing each parameter based on the steps determined in the table, this increase or decrease does not take place at the same step, which can be due to various reasons, including the shadow effect in misdiagnosing the shape of the crown and changing the size of the parts in the estimates.

5. Conclusion

Since the crown area of trees is one of the effective parameters in the interpretation of other tree characteristics, such as weight, carbon deposition, growth rate, etc., therefore, its accurate estimation is inevitable. In this research, one of the most irregular crowns (Elderica pine) was selected to estimate its crown area with the help of UAV images in different parameters. In general, the findings of the research showed that Phantom 4 Pro UAV images have the necessary efficiency in estimating the crown area of single pine trees without field data collection. Also, the advantage of this research is the proper spacing of trees and extraction without crown interference. These results will give managers and planners a clear vision to determine general management policies in the forest area. For future research, the parameters of Compactness, Scale and Shape can be evaluated by other trees and the results can be compared with the results of the current research.

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