

ESTIMATION TREE DENSITY AS OBJECT-BASED IN ARID AND SEMI-ARID REGIONS USING ALOS

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ABSTRACT:

Object-based approaches, which operate at the scale of real-world objects rather than pixels, offer a means of analyzing earth observation data in a realistic context and integrating associated ancillary information to support real-world applications. Arid and semi-arid lands, including desert, scrubland, grassland and savanna, cover about 40%, or an estimated 58.5 million km², of the terrestrial surface. Iran is located in the mid-latitude belt of arid and semi-arid regions cover more than 60% of the country. In this research three case studies were investigated as object-based that are located in the arid and semi-arid regions. In this research two sensors of ALOS satellite including AVNIR-2 that has multispectral band with 10m resolution on the ground and PRISM that has panchromatic band with 2.5m resolution on the ground have been used. The objective of this research is to investigate tree density as object-based using image segmentation and support vector machine (SVM) that is supervised classification with four kernel types including linear, polynomial, radial basis function (RBF), and sigmoid have been applied. Then the results of object-based with ground sampling data on each case study have been evaluated. Pan sharpening image from high-resolution and low resolution has been created. On image pan sharpening sampling plot and sub-sampling plot incorporating it for analyzing were selected. The result of object based for tree density for each case study should be seen and also evaluated with ground sampling data.

1. INTRODUCTION

Biodiversity conservation has become an increasingly important issue in forest management, with forest managers now having to include biodiversity considerations within existing management plans (Ozdemir et al., 2008). The arid and semi-arid areas of northeast Iran consist of about 3.4 million ha populated by two main tree species. One is the broad-leaved *Pistacia vera* and the other is the conifer *Juniperus excelsa* subsp. *Polycarpos*, which Iranians know as Persian juniper and the third case study that is located in other vegetation zone but has same climate condition as above species called *Cupressus sempervirens* var. *horizontalis* belong to *Cupressus* family located in the north of Iran. The morphologically of this species is typically 20 - 30m high, with the crown diameter of 2 - 3m and fruit of this species is wooden with spherical shape. Fisher and Andrew (1995) investigated the status and ecology of *Juniperus excelsa* subsp. *Polycarpos* woodland in the northern mountains of Oman. *Juniperus excelsa* M.-Bieb. subsp. *Polycarpos* (K. Koch) Takhtajan is found from Turkey and Afghanistan eastward and southward to Iran (Fisher and Andrew, 1995). This species generally grows at elevations 1500 to 2900 m above sea level, but is sometimes found in other ranges. *J. excelsa* subsp. *Polycarpos* woodland, and even small increases in climatic stress could imperil the present status of these woodlands (Fisher and Andrew, 1995). In northeast Iran, junipers form open woodlands, with a maximum tree density of approximately 150 trees per hectare (pers. obs., Andrew et al., 1996). Pistachio (*Pistacia vera*), a deciduous-broadleaved species, which is one of the ecologically most important native species of Iran (Yıldız et al., 1998; Safari and Alizadeh, 2007; Miraliakbari and Shahidi, 2008). Pistachio is thought to have been cultivated for 3000–4000 years in Iran. Currently, Iran is the world's largest producer of pistachio, followed by the

United States, where most pistachio production occurs in California. In 2004, Iran and the United States were responsible for 44% and 13% of global pistachio production, respectively (Razavi, 2006). Pistachios are one of the most important non-oil exports from Iran (Fadaei et al., 2007). Natural stands of pistachio are not only environmentally important, but are also genetically important as seed storage for pistachio production in orchards. *C. sempervirens* is not of commercial importance as a timber tree, although its wood is much utilized locally (Phillips, 1948). Yellowish or pale brown in hue and close-grained, it has numerous, fine, inconspicuous medullary rays but rather more distinct growth rings (Elwes and Henry, 1906-1913; Dallimore and Jackson, 1966). It gives off a penetrating odour, which, although agreeable to human beings, is obnoxious to insects, and is reputed to keep moths away (Brown and Laurie, 1968). Light in weight, it is moderately hard and exceedingly durable, and it lasts indefinitely under water. However, hot, dry weather conditions in the region can make forest inventory work on the ground difficult. Moreover, ground surveys require much time, labor, and money, even when using GPS equipment. In contrast, the use of remote-sensing data for performing forest inventories in arid and semi-arid areas is more cost-effective, less time-consuming, and less labor-intensive (Fadaei and Kolahi, 2008). Presently, natural resource managers are beginning to use remotely sensed satellite imagery to calculate the density, species, and structure states of forests (Moskal et al., 2003).

2. MATERIAL AND METHOD

2.1 Study area

This research was carried out in the three case studies, both of them located in the northeast vegetation zone of Iran that called the Irano-Touranian zone, and the third case study is Zabin

forest that is located in Hyrcanian vegetation zone in north of Iran (Figure 1).

- (1): The study site, located in northeast Iran at 37°20'31.19"-37°18'22.30"N and 58°49'59.13"-58°52'34.40"E, respectively.
- (2): The study site, located in northeast Iran at 36°17'2.60"-36°7'2.09"N and 60°30'21.91"-60°30'18.22"E respectively.
- (3): The study site, located in north Iran at 36°29'59.56"N 51°21'48.09"E.

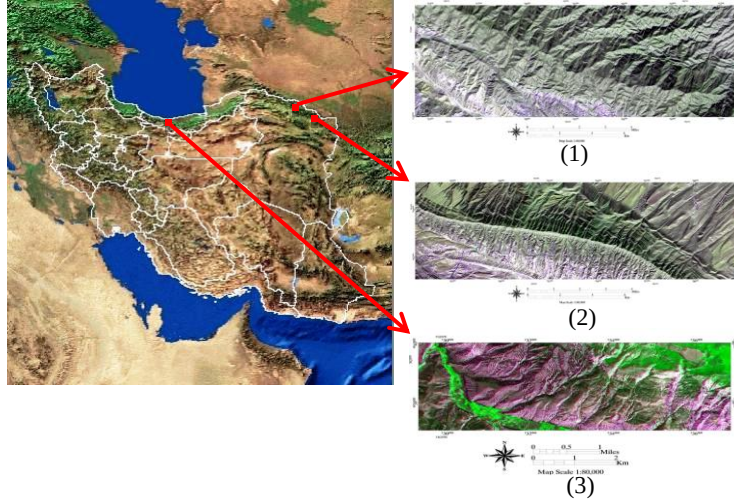


Figure 1. Location of case studies

2.2 Satellite data

The ALOS (Advanced Land Observing Satellite) satellite imagery was used; this satellite was launched on 24 January 2006 by Japan. ALOS satellite image data acquired on 21 July 2009 was used for the analysis. ALOS uses the Advanced Visible and Near Infrared Radiometer type two (AVNIR-2) sensor, which is a multispectral band. This sensor contains of four bands, band1 [blue, 0.42 - 0.50 μm], band2 [green, 0.52 - 0.60 μm], band3 [red, 0.61 - 0.69 μm] and band4 [near infrared, 0.76 - 0.89 μm] respectively. The spatial resolution is 10m at the nadir. In addition, ALOS uses the Panchromatic Remote-Sensing Instrument for Stereo Mapping (PRISM) consisting of this optics, 1- forward, 2- backward 3- nadir. They consist of one band with wavelength 0.52-0.77 μm and spatial resolution is 2.5m at the nadir, and swath width 70km at the nadir and 35km at the triplet mode. The field of view is +/-1.5 deg and Quantization (image processing) that can observe the surface of the earth is 8 Bit (Table 1).

Case studies	Data	Date acquired		Summary
(1)	AVNIR-2	MS	2007/10/25	40,1B2,0-2%
	PRISM	Pan, nadir	2007/10/25	40,1B2,0-2%
(2)	AVNIR-2	MS	2007/07/03	40,1B2,0-2%
	PRISM	Pan, nadir	2008/06/06	40,1B2,0-2%
(3)	AVNIR-2	MS	2009/07/21	41,1B2,0-2%
	PRISM	Pan, nadir	2008/08/28	41,1B2,0-2%

Table 1. Avnir-2 and Prism data

2.3 Methodology

We applied object-based method for tree extraction, first of all I will explain and shows the diagram of object-base and shows the diagram of it that has been applied for three case studies.

2.4 Object base

Figure 2 illustrates the flowchart of object base method for tree density. We used the pan-sharpening image for object base method. Image segmentation is the process of partitioning an image into segments by grouping Neighboring pixels with similar feature values (brightness, texture, color, etc.), these segments ideally correspond to real-world objects (Malik et al.1999). In the image pan sharpening, we applied image segmentation by merging the similar segments. Then we obtain training data on the image segmentation by using ground-sampling data to prepare for support vector machine (SVM) classification. On this classification, we applied four kernel types that will be explained in the following text. Finally, we got the result of tree density by this method.

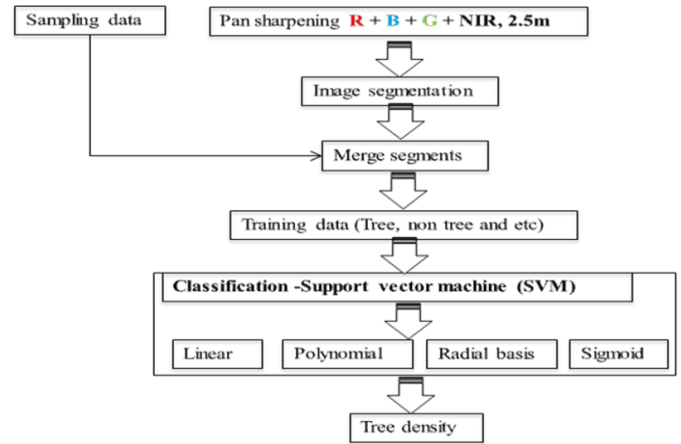


Figure 2. Flowchart of object base methodology

2.5 Image segmentation

ENVI EX as the newest addition to the ENVI line of premier image processing has been employed an edge-based segmentation algorithm that is very fast and only requires one input parameter. (Hsu et al.2007) has explained the theoretical of Support Vector Machine algorithm. Support Vector Machine (SVM) is a classification system derived from statistical learning theory that provides good classification results from complex and noisy data. The SVM classifier provides four types of kernels: linear, polynomial, radial basis function (RBF), and sigmoid. These kernels are calculated using the following equations (Table 2).

Linear	$K(x_i, x_j) = x_i^T x_j$
Polynomial	$K(x_i, x_j) = (\mathcal{G} x_i^T x_j + r)^d, \mathcal{G} > 0$
RBF	$K(x_i, x_j) = \exp(-\mathcal{G} \ x_i - x_j\ ^2), \mathcal{G} > 0$
Sigmoid	$K(x_i, x_j) = \tanh(\mathcal{G} x_i^T x_j + r)$

Table 2. Equations of four types of kernels in SVM

Sigmoid $K(x_i, x_j) = \tanh(\mathcal{G} x_i^T x_j + r)$
where:

g is the gamma term in the kernel function for all kernel types except linear.

d is the polynomial degree term in the kernel function for the polynomial kernel.

r is the bias term in the kernel function for the polynomial and sigmoid kernels.

g, d, and r are user-controlled parameters, as their correct definition significantly increases the accuracy of the SVM solution.

Now is easy to select the target object in the segment for estimation of tree density as the main parameter for forest inventory (Figure 3).

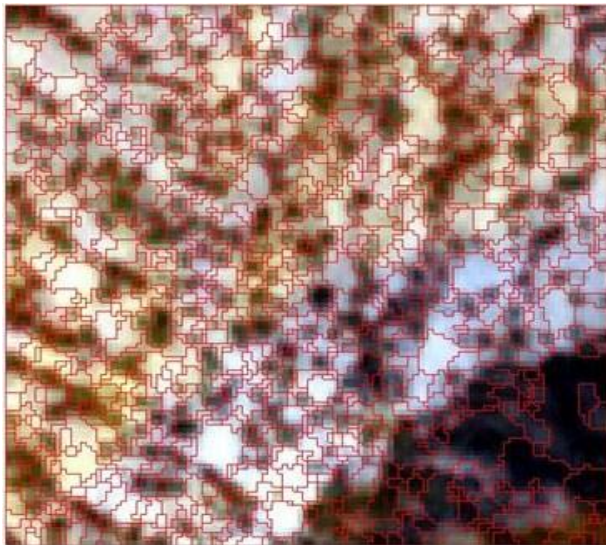


Figure 3. The perspective of image segmentation

2.6 Ground sampling data

The coordinates of each corner and center of each sub-sample plots (9 ha) in the pan sharpening image determined and were input to the GPS device. Using GPS, we tried to find the corner position for each sub-sample plot and then collected the sampling ground data. With helping of natural resource organizations in the region, started to collect the sampling ground data in the sub-sample plots on the field forest. Field surveys took place at the end of October 2009.

3. RESULT

We calculated coefficients of linear regression between tree density from object-based method and tree density for each sub-sample plot was found from field surveys. The each sub-sample plot from ALOS satellite data was 9 ha.

3.1 The relationship between ground data and tree extraction from object based

The coefficient of determination between tree extractions (tree number) from object based and ground sampling data for the first case study has been evaluated (Table 2).

METHOD		R ² (Coefficient of determination)
Object base (SVM)	LINEAR	0.44
	POLYNOMIAL	0.47
	RADIAL BASIS	0.43
	SIGMOID	0.53

Table 2. Simple regression coefficient between object-based and tree density

The coefficient of determination between tree extractions (tree number) from object based and ground sampling data for the second case study has been evaluated (Table 3).

METHOD		R ² (Coefficient of determination)
Object base (SVM)	LINEAR	0.47
	POLYNOMIAL	0.44
	RADIAL BASIS	0.46
	SIGMOID	0.34

Table 3. Simple regression coefficient between object-based and tree density

The coefficient of determination between tree extractions (tree number) from object based and ground sampling data for the second case study has been evaluated (Table 4).

METHOD		R ² (Coefficient of determination)
Object base (SVM)	LINEAR	0.48
	POLYNOMIAL	0.45
	RADIAL BASIS	0.49
	SIGMOID	0.54

Table 4. Simple regression coefficient between object-based and tree density

4. DISCUSSION AND CONCLUSION

Object base also used for tree extraction as one method, this method is able to extract multiple features at a time such as vehicles, buildings, roads, bridges, rivers, lakes, and fields. Also more researcher use this method for image processing, but the result for this method in the arid and semi-arid land showed was not useful and skilful because the target object was so small in the large background with fine resolution. Object based method is a widely used tool for mapping and monitoring forests. We achieved mostly same result for three case studies. The result of this method shows the species of their regions are so small and also the image satellite has not enough resolution to get more credible result for object-based analysis. To obtain an improved classification result, we should select and combine the most effective textural/spatial in the support vector machine supervised classification to identified more accurate features. Using different texture features with their own optimal directions and improve the some parameter in the SVM

algorithm can depict land cover better (SU et al., 2008). We applied one research by very high resolution Ariel photograph (UAV) and we will apply SVM algorithm by improving the parameter to identification high accurate feature. We are going to improvement SVM algorithm to get more remarkable result as object-based method.

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