ESTIMATING CROWN PARAMETERS FROM SPACEBORNE HIGH RESOLUTION IMAGERY

[1]Choen Kim and [2]Sung-Hoo Hong
[1]Dept. of Forest Resources, Kookmin University
[2]Dept. of Applied Information Technology, Kookmin University,
Seoul 136-702, Korea
[1]Phone: +82-2-910-4813 [1] Fax: +82-2-910-4809
[1]E-mail: choenkim@kookmin.ac.kr

ABSTRACT… Crown parameters are important roles in tree species identification, because the canopy is the aggregate of all the crowns. However, crown measurements with spaceborne image data have remained more difficult than on aerial photographs since trees show more structural detail at higher resolutions. This recognized problem led to the initiation of the research to determine if high resolution satellite image data could be used to identify and classify single tree species. In this paper, shape parameters derived from pixel-based crown area measurements and texture features derived from GLCM parameters in QuickBird image were tested and compared for individual tree species identification. As expected, initial studies have shown that the crown parameters and the canopy texture parameters provided a differentiating method between coniferous trees and broad-leaved trees within the compartment(less than forest stand) for single extraction from spaceborne high resolution image.

KEY WORDS: Single tree species identification, Crown parameter, Formfactor, Fractal dimension

1. INTRODUCTION

Precision forestry is one of the key policy drivers related to the Sustainable Forest Management(SFM) in Korea and worldwide as well. In particular, SFM requires the collection of site specific information to forest structural assessments. Precision forestry therefore will need spatially explicit mapping biomass and monitoring forest stand structure derived from high resolution satellite imagery.

Although a number of study have made meaningful progress on single tree species detection and classification, the developed methods in the images lacked low spatial resolution and variability of illumination due to topographic effects for individual species crowns identification(Leckie et al., 2003&2005; Larson, 2007; Hirschmugl, 2007).

For this reason, we explored the individual crown size measurements to separate two kind of forests into conifers and broad-leaved trees at Kwangneung Experiment Forest, Korea by using QuickBird.

To support the measurements of crown sizes we also produced the Gray Level Co-occurrence Matrix(GLCM)-based texture features to provide textural discrimination of the canopy structures.

2. STUDY AREA AND DATA

For the performance of single tree species identification, the study site was selected, which includes 2 mixed trees compartments(no.43 and no.59) in Kwangneung Experiment Forest. The study area is situated in 127 °12 ′05 ″ North in latitude and 37 °70 ′50 ″-37 °81 ′32 ″ East in longitude.

The QuickBird(QB) image data for the area were obtained at 11: 21 AM on 5 April 2005, with a solar elevation of 54.4° and a sun azimuth of 147.8°. The QB multi-spectral bands(Blue: 450-520nm, Green: 520-600nm, Red: 630-690, NIR: 760-900nm) with spatial resolution of 2.4m are not applicable to the observation of an individual tree. Therfore, the QB multi-spectral data were fused with the 0.6m panchromatic band(450-900nm) using a pan-sharpening algorithm to make the pan-sharpening MS image data with 0.71m ground sample distance(GSD).

3. METHODOLOGY

3.1 Texture Features

The texture parameters used in the canopies analyses consist of homogeneity, dissimilarity, entropy, and angular second moment(ASM) and are explained in this section. Homogeneity and dissimilarity in the image are adjusted with Grey Level Co-occurrence Matrix(GLCM) be generated from which the texture features are derived(Haralick et al., 1973; Peralstine et al., 2005). And Neighboring Grey Level Dependence Matrix(NGLDM) texture feature produce measures of image second moment and image entropy(Sun and Wee, 1983; Peralstine et al., 2005). Table 1 summarizes the parameters calculated as combination of texture measurements. The texture features images are shown in Figure 1.

3.2 Shape Parameters

To prove the single tree discrimination, 2 important shape parameters were used to measure the sizes of the identified crowns in the image.

First, formfactor that varies with surface irregularities is given by

$$F = \frac{4\pi \cdot Area}{Perimeter^2}$$

Table 1. Texture parameters. F(i, j) is the brightness values of the pixel located at ith row and jth column in the kernel window, and N is the pixel number of the kernel window

Parameter	Expression
Homogeneity	$\sum_{i=0}^{N-1}\sum_{j=0}^{N-1}\frac{f(i,j)}{1+\lvert i-j\rvert}$
Dissimilarity	$\sum_{i=0}^{N-1}\sum_{j=0}^{N-1} f(i,j)\lvert i-j\rvert$
Entropy	$\sum_{i=0}^{N-1}\sum_{j=0}^{N-1} f(i,j)\cdot\log(f(i,j))$
ASM	$\sum_{i=0}^{N-1}\sum_{j=0}^{N-1} f^2(i,j)$

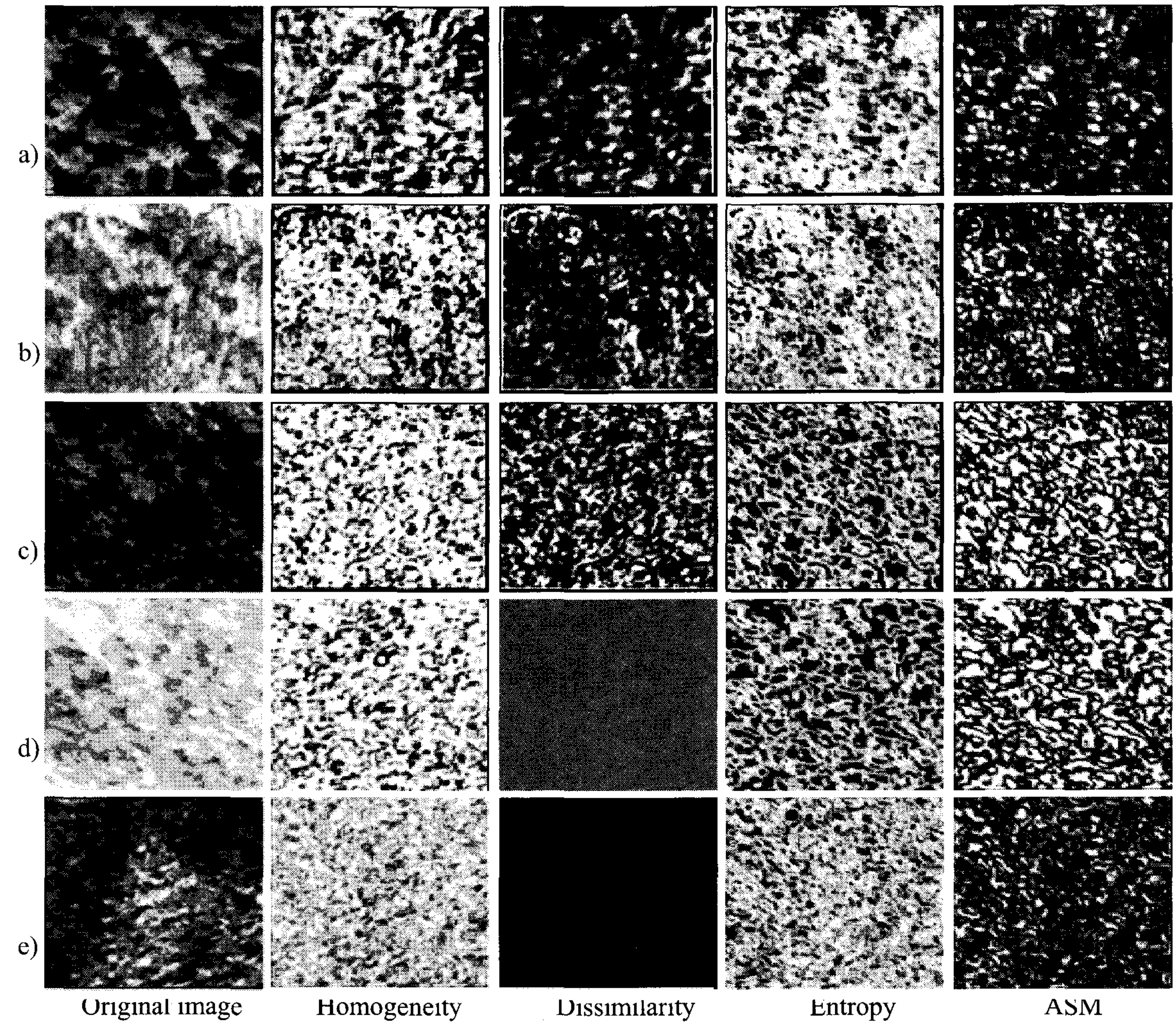
Fractal dimension for the defined crowns was calculated as

$$FD = \frac{2\log(perimeter/4)}{\log area}$$

4. RESULTS AND DISCUSSION

In comparing the visual discrimination of the texture features images, the dissimilarity texture produced no difference in the western and southern slope shown in figure 1. The NGLDM texture features showed a good separation between conifers and mixed trees.

Table 2 and Figure 2 indicate that both fractal dimension and formfactor provided significant discrimination between conifers and broad-leaved trees in the image. Whereas fractal dimension values of coniferous trees are lower than those of broad-leaved trees, formfactor values of coniferous trees are higher than those of broad-leaved trees.



a) coniferous tree in the southern slope of 43 compartment, b) broad-leaved tree in the eastern slope of 43 compartment, c) Mixed tree in the northern slope of 59 compartment, d) Mixed tree in the western slope of 59 compartment, e) Broad-leaved tree in the southern slope of 59 compartment

Figure 1. Textural feature of Kwangneung Experiment Forest detected by using parameters (see Table 1) with 3 by 3 window, with a co-occurrence shift, and with grayscale quantization level of 64 (126 - by - 126 - pixel section)

Table 2. The numeric values for area, perimeter, formfactor and fractal of each 10 sample individuals in coniferous trees(a) and broad-leaved trees(b) of 43 compartment, Kwangneung Experiment Forest

a)

con. sample	area (m^2)	perimeter (m)	form factor	fractal
s1	116.276	56.970	0.450	1.117
s2	101.341	54.900	0.423	1.134
s3	124.039	58.050	0.463	1.110
s4	84.725	42.503	0.589	1.065
s5	101.317	49.703	0.515	1.091
s6	206.524	87.098	0.342	1.156
s7	394.772	131.625	0.286	1.169
s8	119.251	58.050	0.445	1.119
s9	71.391	35.258	0.722	1.020
s10	79.040	43.605	0.522	1.093
avg.	139.868	61.776	0.476	1.107

b)

b.-l. sample	area (m^2)	perimeter (m)	form factor	fractal
s1	276.694	125.370	0.221	1.225
s2	324.061	129.645	0.242	1.203
s3	187.084	123.300	0.155	1.311
s4	124.785	60.120	0.434	1.123
s5	126.441	81.922	0.237	1.248
s6	242.226	114.052	0.234	1.221
s7	115.694	74.678	0.261	1.232
s8	135.852	72.585	0.324	1.180
s9	104.329	44.595	0.659	1.038
s10	140.485	68.445	0.377	1.149
avg.	177.765	89.471	0.279	1.200

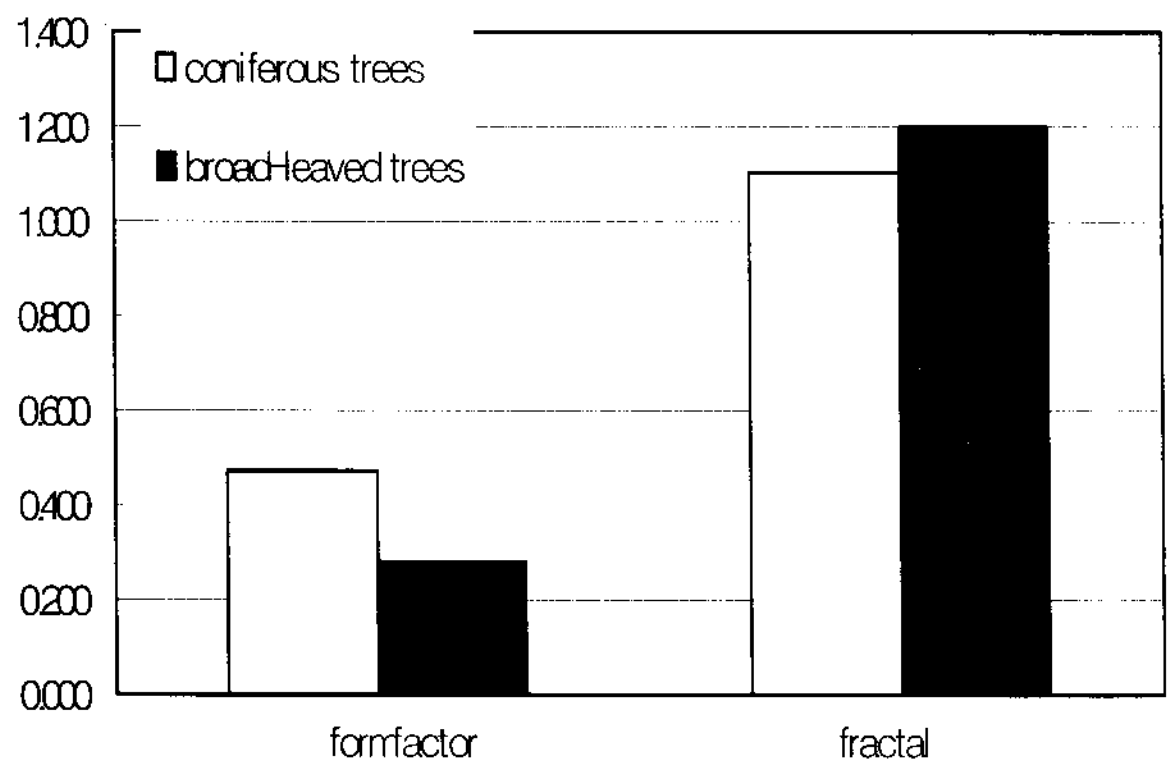


Figure 2. Histographic representation of comparing fractal dimension values with formfactor values for each 10 sample individuals in coniferous trees and broad-leaved trees of 43 compartment, Kwangneung Experiment Forest

5. CONCLUSIONS

The potential for using shape parameters of crowns for individual trees species identification in spaceblrne imagery with 0.7m spatial resolution seems to be promising.

REFERENCES:

Hirschmugl, M., M.Ofner, J.Raggam, and M. Schardt, 2007. Single tree detection in very high resolution remote sensing data. Remote Sensing of Environment, 110, pp.533-534.

Larsen, M., 2007. Single tree species classification with a hypothetical multi-spectral satellite. Remote Sensing of Environment, 110, pp. 523-532.

Leckie, D.G., F.A. Gougeon, N. Walsworth, and D. Paradine, 2003. Stand delineation and composition estimation using semi-automated individual tree crown analysis. Remote Sensing of Environment, 85, pp. 355-369.

Leckie, D.G., S. Tinis, C. Burnett, F.A. Gougeon, and E. Cloney, 2005. Issues in species classification of trees in old growth conifer stand. Canadian Journal of Remote Sensing, 31(2), PP.175-190.

R.M. Haralick, K. Shanmugam, and I. Dinstein, 1973. Textural features for image classification, IEEE Trans. On Systems, Man, and Cybernetics, Vol. SMC-3, No.6, pp. 610-621.

Pearlstine, L., K.M. Portier, and S.E. Smith, 2005. Textural discrimination of an invasive plant, shinus terebinthifolius, from low altitude digital imagery. Photoframmetric Engineering & Remote Sensing, 71(3), pp. 289-298.