DISCRIMINATING MAJOR SPECIES OF TREE IN COMPARTMENT FROM OPTIC IMAGERY AND LIDAR DATA

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ABSTRACT: In this paper, major species of tree were discriminated in compartment by using LiDAR data and optic imagery. This is an important work in forest field. A current digital stock map has created the aerial photo and collecting survey data. Unlike high resolution imagery, LiDAR data is not influenced by topographic effects since it is an active sensory system. LiDAR system can measure three dimension information of individual tree. And the main methods of this study were to extract reliable the individual tree and analysis techniques to facilitate the used LiDAR data for calculating tree crown 2D parameter. We should estimate the forest inventory for calculating parameter. 2D parameter has need of area, perimeter, diameter, height, crown shape, etc. Eventually, major species of tree were determined the tree parameters, compared a digital stock map.

KEY WORDS: LiDAR, Digital Stock Map, Individual Tree, Crown Parameter

1. INTRODUCTION

A digital stock map include various information; forest type, diameter class, age class, density. The process of digital stock map must go through several steps. Interpretation is the first step in digital stock map, which is followed drawing, cartography, analysis, production, display. A current digital stock map has created the aerial photography. The digital stock map based on aerial photography has been spent a lot of time or money for the whole country.

The study extracted forest type using by LiDAR(Light Detection And Ranging). LiDAR is an active sensory system that uses light, laser light, to measure distance. When mounted in an airborne platform, this device can rapidly measure distances between the sensor on the airborne platform and points on the ground.

LiDAR data consists of points which provide three dimensional information of terrain surface and intensity data which reflects characteristics of the materials. Recently, most LiDAR-related studies of forest typically have focused on the measurement of tree height because LiDAR system can measure height of tree quickly (Lee et al. 2006, McCombs et al. 2003).

To discriminate forest type, many studies based on various remote sensing data have been performed. Using satellite imagery, update digital stock map compared with traditional methods(Sung and Cho, 2004). Using aerial orthophoto, construct forest information management system with import forest information(Kim et al., 2004).

However, a number of studies have significant difficulty on detection of individual tree due to lack of spatial resolution and topographic effects(Leckie et al., 2003&2005; Larson, 2007; Hirschmugl, 2007). Unlike high resolution imagery, LiDAR data is not influenced by topographic effect since it is an active sensory system. That's why this study carried out following process. First, individual trees were extracted in rasterized LiDAR data. Second, extracted individual trees were divided from the eight aspects. Third, crown parameters were calculated from individual trees for quantitative analysis and discriminated forest type.

2. STUDY AREA AND DATA

The study area was selected in Kwangneung Experiment Forest of South Korea.

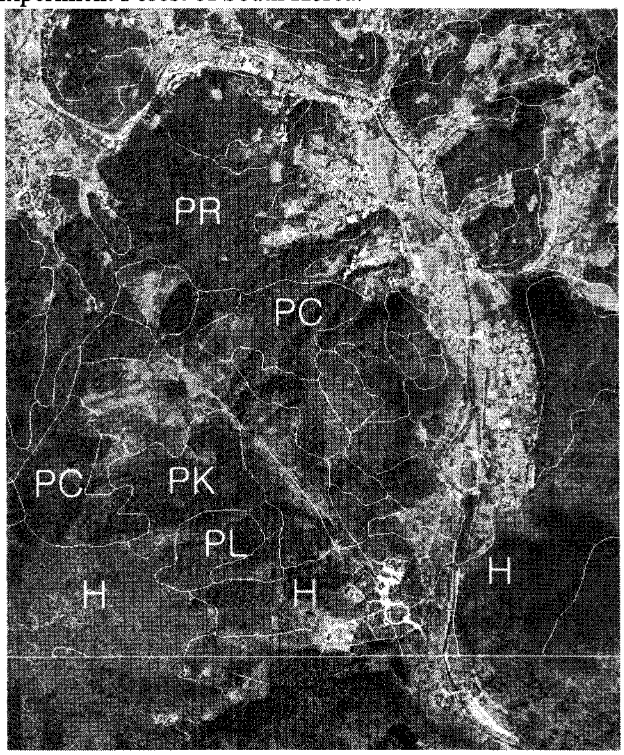

Figure 1. Study area of Kwangneung Experiment Forest using by airborne Imagery((PR: Pitch pine forest, PL: Japanese larch forest, PK: Korean Pine, PC: Artificial coniferous tree forest, H: Broad-leaved tree forest)

Table 1. Characteristic of LiDAR data

	Acquisition Date	Point density(Point/m^2)
LiDAR	2007-04-03	2.590 point/m^2

The Kwangneung experiment forest is one of the most typical forests in South Korea. The study area cut a map on the scale of one-five-thousandth size from aerial photo and LiDAR data. We have been performed to discriminate three forest type expect mixed forest mixed sta in this study site. A used digital stock map is a map on the scale of one-twenty five-thousandth, it consist of forest type, diameter class, age class, density. And this study area include 4 compartments(17 compartment: area 46.30ha, volume 182m^3, increment 6.2m^3/ha, 18 compartment: area 20.48ha, volume 212m^3, increment 1.7m^3/ha, 30 compartment: area 33.53ha, volume 282m^3, increment 9.5m^3/ha, 32 compartment: area 27.44ha, volume 184m^3, increment 1.6m^3/ha)(Korea Forest Research Institute, 2003).
LiDAR scanning system, OPTECH ALTM 3070, was used to obtain LiDAR data(Table 1).

3. EXPERIMENTAL METHOD

3.1 To Extract Peak Point of Individual Trees

The NDSM(Normalized Digital Suface Model) is subtracted value from the DSM(Digital Surface Model) and the DTM(Digital Terrain Model) with each 0.25m pixel. The DEM was created through interpolation of the last return of LiDAR data points. An iterative filtering approach was used to remove data points not reflected from the ground surface(McCombs *et al.* 2003). There are many holes on the NDSM like at the crown of a tree. These holes were removed for a clear distinction of a individual tree using by morphology operation. Mathematical morphology provides a quantitative approach to the analysis to the analysis of geometric structure within the canopy surface model. In particular, a specific sequence of binary and grayscale morphological image transformations can be used to isolate individual trees composing the canopy surface, which in turn can drive an individual tree measurement algorithm(Hans, E.A. *et al.*2001).And peak point of a individual tree were extracted moving window filtering for accurate number of individual tree by using matlab(Figure.2).

3.2 Estimation of Crown Parameter

To demonstrate the individual tree identification, several crown parameters were used to calculate the crown shape in the image.
First, formfactor for irregular condition of crown perimeter is given by

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

Secondly, compactness is also used to determine the irregularity of crown boundaries as the inverse metric of the thinness, and is given by

$$C = \frac{\sqrt{(4/\pi)} \cdot Area}{MaximumDiameter}$$

Thirdly, elongation is to measure the ratio of the major axis of the polygon to the minor one. The elongation value for a square is 1.0, and the value for a rectangle is greater than 1.0(Douglas et al., 1973), and is given by

$$E = \frac{MaximumDiameter}{MinimumDiameter}$$

3.3 Discrimination of Forest Type

The discrimination of the forest type was determined as the following. Calculated parameters were divided into four aspects of 90°. The parameters of the forest type compared with the different aspect, and found correlation between aspect and parameter.
Finally, obtained parameters in the second step were compared with a digital stock map.

4. RESULTS AND DISCUSSION

4.1 To Extract Peak Point of Individual Trees

A peak point of trees were found through moving window filtering from extracted individual tree in NDSM(Figiure3). For rasterized LiDAR data, moving window were required window size 15 by 15, otherwise the filtering may give an inaccurate result because crown diameter of study area is above four meters.

1	2	4	2	7	6	4
3	2	2	4	5	5	4
2	4	4	9	4	6	3
3	3	2	2	5	4	3
3	3	4	4	5	6	4
4	5	4	4	3	5	4
2	2	2	3	1	3	3

Window position 1

⇨

0	0	0	0	0	0	4
0	0	0	0	0	0	4
0	0	0	9	0	0	3
0	0	0	0	0	0	3
0	0	0	0	0	0	4
4	5	4	4	3	5	4
2	2	2	3	1	3	2

Window position 2

⇨

0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	9	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

Window final position

Figure 2. Extracting peck point of individual tree by using moving window filtering

Figure 3. Extracted peak point of individual tree(+: peak point)

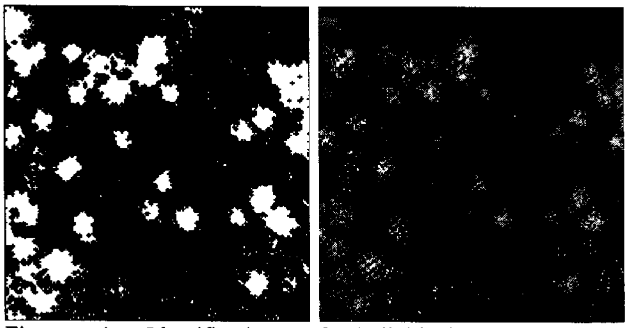

Figure 4. Identification of individual tree through morphological operations

The results of extracted individual tree are showed in Figure 4. This figure indicates the relative performance of the morphology-based tree measurement algorithm.

4.2 Estimation of Crown Parameter

Table 2 indicates formfactor which come under the crown parameter provided significant discrimination among three species of the trees.

It can be noted that formfactor and compactness values of Pitch Pine are lower than among others. This can be due to the fact that crown boundaries of Pitch Pine have more roughness than Japanese Larch and Korean Pine. However, elongation values are not necessarily correlated in three species.

4.3 Discrimination of Forest Type

Table 2 shows the parameter values in four aspects. As can be seen from table2, aspect is not affected to discriminate tree species for determining forest type.

That reason we were performed to discriminate in mixed forest area using formfactor and compactness.

As a result, we can obtain approaching the parameter value of individual tree calculated result value.

5. CONCLUSION

This study showed that LiDAR data can be used to detect and characterize forest for discriminating forest type. As can be seen from the results in this study, the formfactor, compactness and elongation that are performed on each of extracted individual trees using LiDAR data. Further study is needed to relate these measurements to field-based tree measurements.

Table 2. Statistical values for formfactor, compactness, elongation

		Pinus Koraiensis (Korean Pine)	Larix Kaemferi (Japanese Larch)	Pinus Rigida (Pitch Pine)
Formfactor	315°-360°, 0°-45°	0.471	0.570	0.339
	45°-135°	0.497	0.595	0.484
	135°-225°	0.510	0.703	0.450
	225°-315°	0.475	0.660	0.339
	average	0.488	0.632	0.442
Compactness	315°-360°, 0°-45°	0.224	0.240	0.185
	45°-135°	0.227	0.245	0.221
	135°-225°	0.237	0.259	0.224
	225°-315°	0.219	0.267	0.213
	average	0.227	0.253	0.211
Elongation	315°-360°, 0°-45°	1.173	1.087	1.199
	45°-135°	1.373	1.092	1.312
	135°-225°	1.139	1.316	1.032
	225°-315°	1.219	1.199	1.544
	average	1.226	1.173	1.272

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