EXARCTION OF INDIVIDUAL TREE CHARACTERISTIC BY USING AIRBORNE LIDAR DATA

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ABSTRACT: Mounted in aircraft, LiDAR (Light Detection And Ranging) technology uses pulses of light to collect data about the terrain below. The main objective of this study was to extract reliable the individual tree and analysis techniques to facilitate the used LiDAR data for estimating tree crown diameter by measuring individual trees identifiable on the three dimensional LiDAR surface. In addition, this study can be quantitative analysis of individual tree through the canopy parameter.

KEY WORDS: LiDAR, Crown Density, Canopy Parameter

1. INTRODUCTION

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. In recent years, applications of LiDAR sensors have grown rapidly, due to two technological developments. First, electro-mechanical technology gas improved scanners and lasers to the point that they can be accurately and reliably controlled in a moving aircraft. Second, aircraft positioning using Global Positioning System, or GPS, and Inertial Navigation Systems, or INS, technology has advanced to the point that aircraft position and orientation can be continuously determined to high level of precision(Edward *et al.* 2001).

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).

LiDAR system also has another advantage about topographic effect. 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, pull out points at originally LiDAR point data for measurement of crown density. Third, canopy parameters were calculated from individual trees for quantitative analysis and classification of forest stand structure.

2. STUDY AREA AND DATA

The study area was selected in Kwangneung Experiment Forest of South Korea. The Kwangneung experiment forest is one of the most typical forests in Korea. The Kwangneung Experiment Forest consists of sixty-five compartments. This study selected 5 sample areas of 100m x 100m at 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).

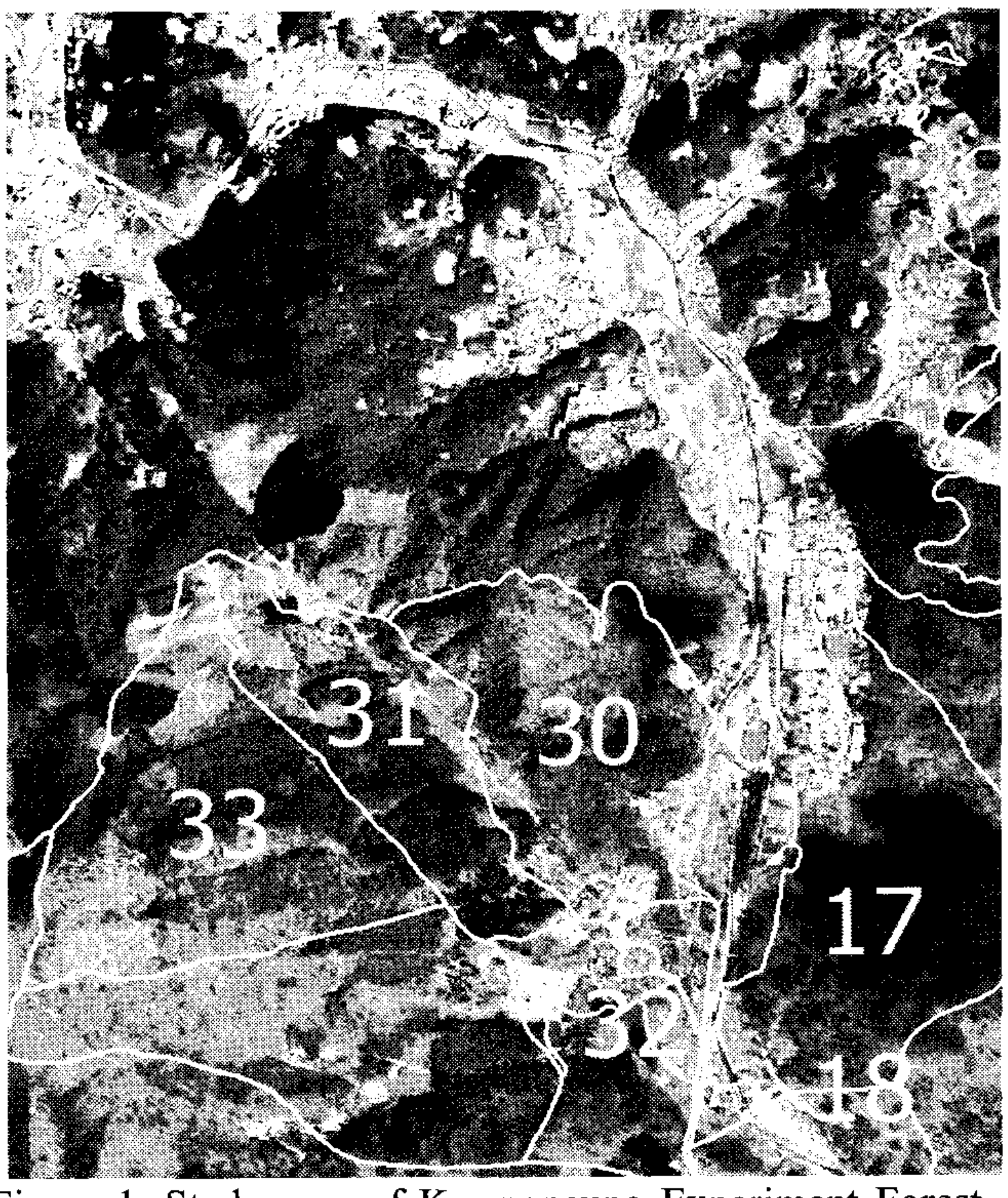


Figure 1. Study area of Kwangneung Experiment Forest using by airborne Imagery

Table 1. Characteristic of LiDAR data

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

3. EXPERIMENTAL METHOD

Figure 2 shows a flowchart of data processing. The study were used ArcGIS(measurement of crown density), Erdas Imagine(extraction of individual tree), ENVI(conversion of LiDAR data, morphology operation), TerraScan(classification of LiDAR data) for data processing.

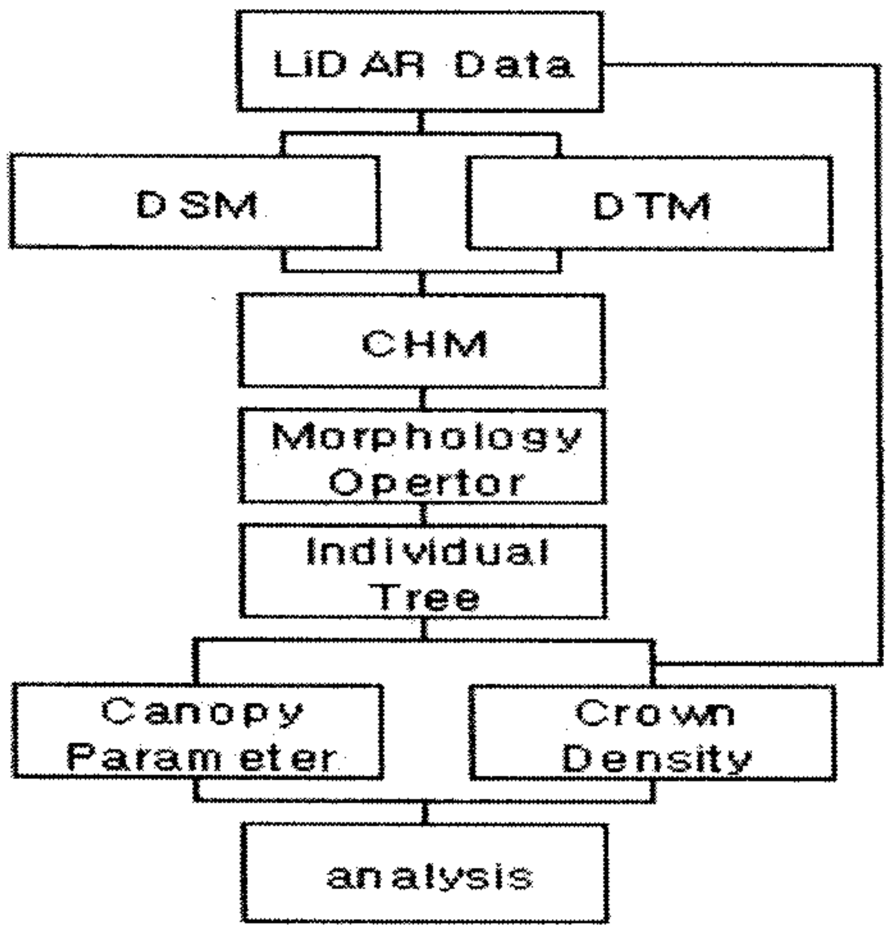


Figure 2. Flowchart of data processing

3.1 Extraction of Individual Tree

The CHM(Canopy Height Model) was manufactured as the difference the DEM(Digital Elevation Model) and the DTM(Digital Terrain Model) with each 0.5m pixel. The DEM was created through interpolation of the last return 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 CHM like at the crown of a tree. These holes were removed for a clear distinction of 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). The study ruled out the crowded forest because this LiDAR data had a lower point density and to avoid bad influence for crown density.

3.2 Measurement of Crown Density

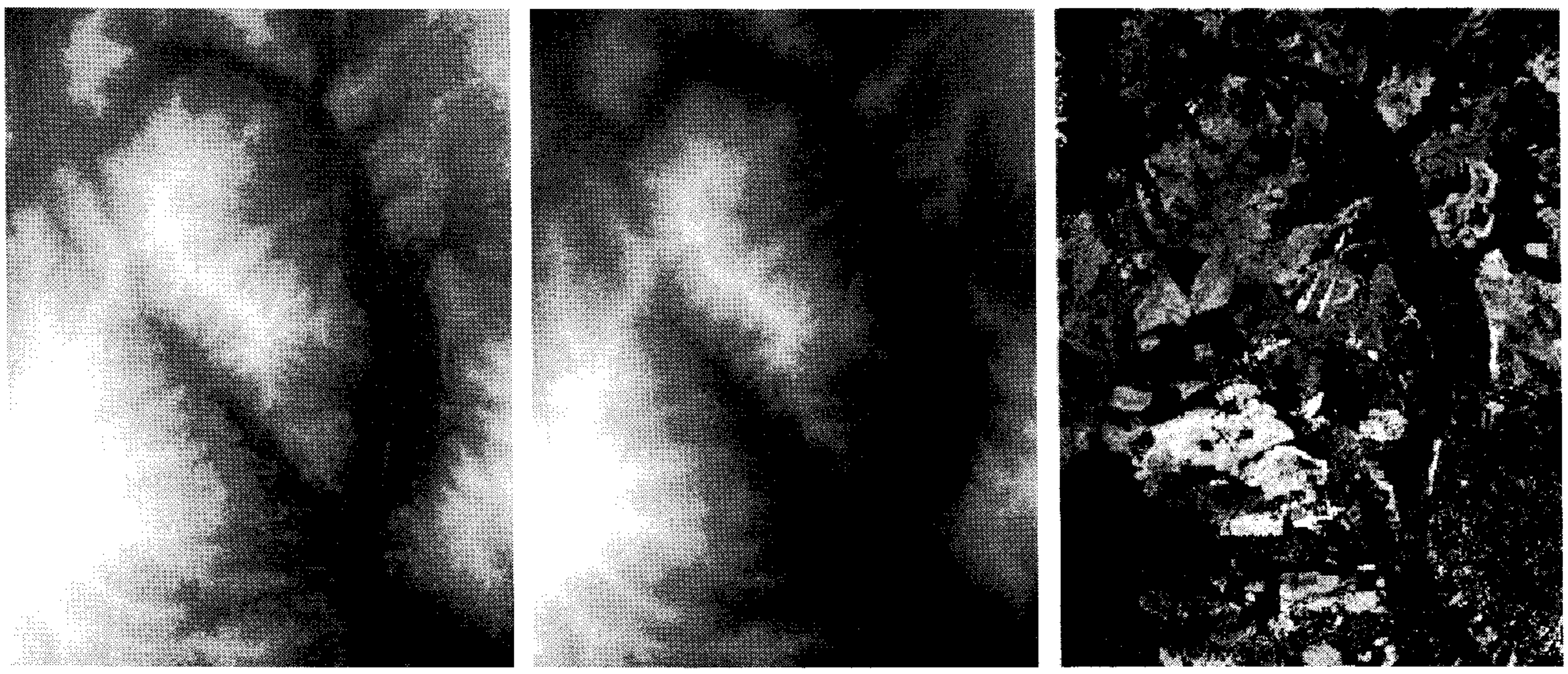
The crown density was determined as follows. First, extracted individual tree was selected trees of similar area and height and was converted vector format. Second, the crown density was pulled out from LiDAR point data by using converted vector formats and counted points inside of the vector formats.

3.3 Estimation of Canopy Parameter

The estimates of crown diameter based on LiDAR were determined by locating the crown edge in each individual tree. The study was used in the formfactor and roundness among the canopy parameters for quantitative analysis. The formfactor signifies irregular condition of canopy perimeter and the roundness signifies round condition of canopy shape.

Table 2.Expression of canopy parameter

Parameter	Formfactor	Roundness
Expression	$F = \frac{4\pi \cdot Area}{Perimeter^2}$	$R = \frac{4 \cdot Area}{\pi \cdot Maximum\ Diameter^2}$



a) DSM b) DEM c) CHM

Figure 3. Manufactured imagery(pixel size : 0.5m) for extraction of individual tree

4. RESULTS AND DISCUSSION

4.1 Extraction of Individual Tree

Figure 3 shows the DSM, DEM, and CHM in Kwangneung Experiment Forest. The manufactured CHM was more than 3m on the ground to eliminate forestvegetation at the lower part. The results of extracted individual tree are showed in Figure 4. This figure indicates the relative performance of the morphology-based tree measurement algorithm.

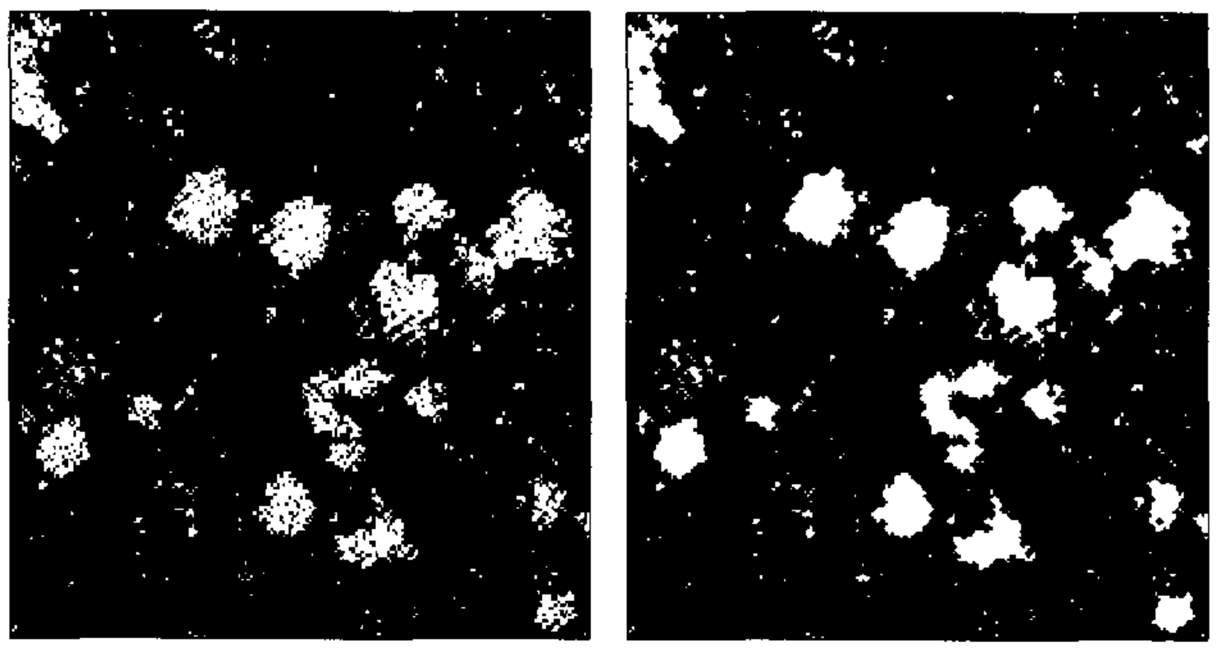
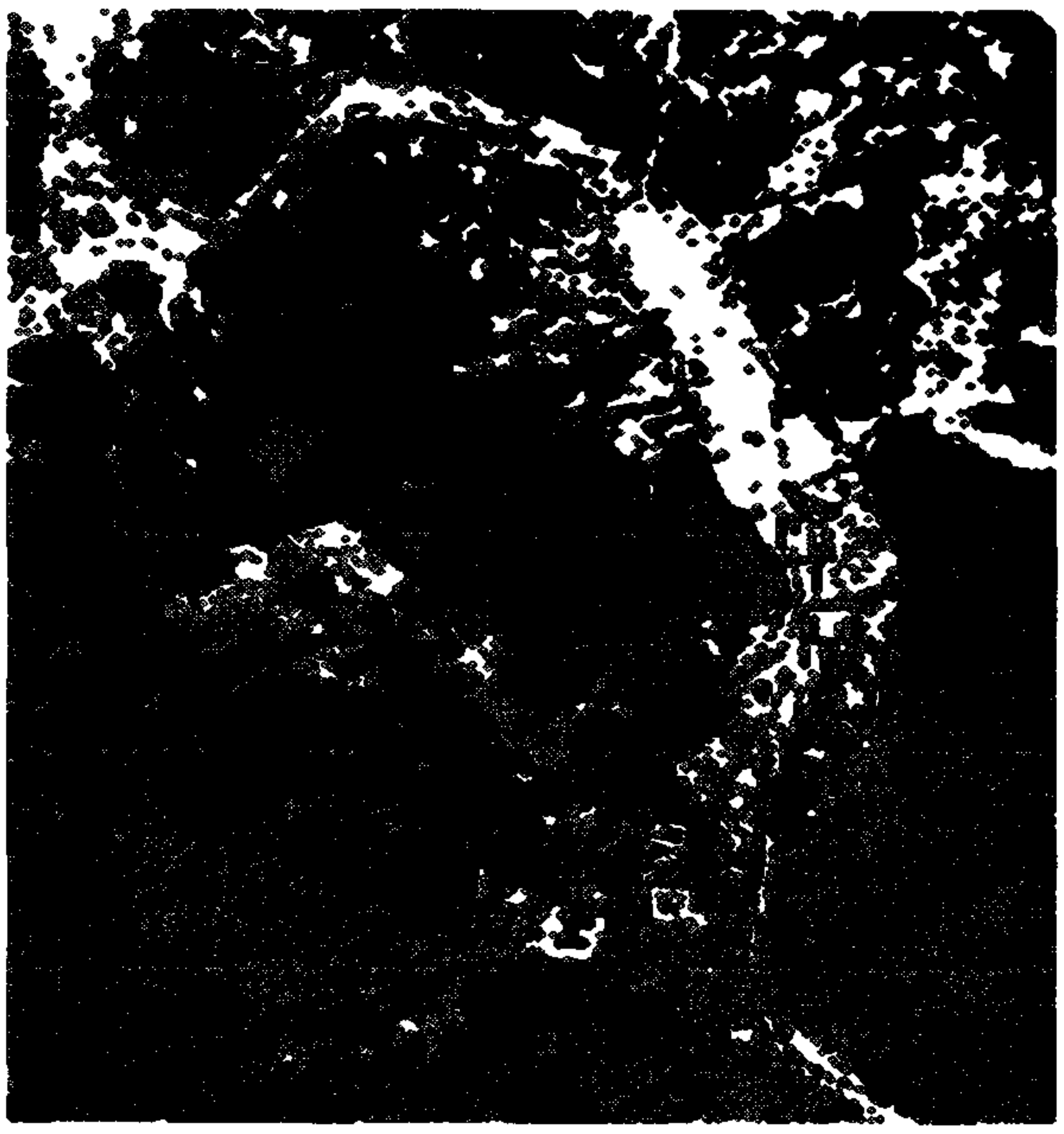
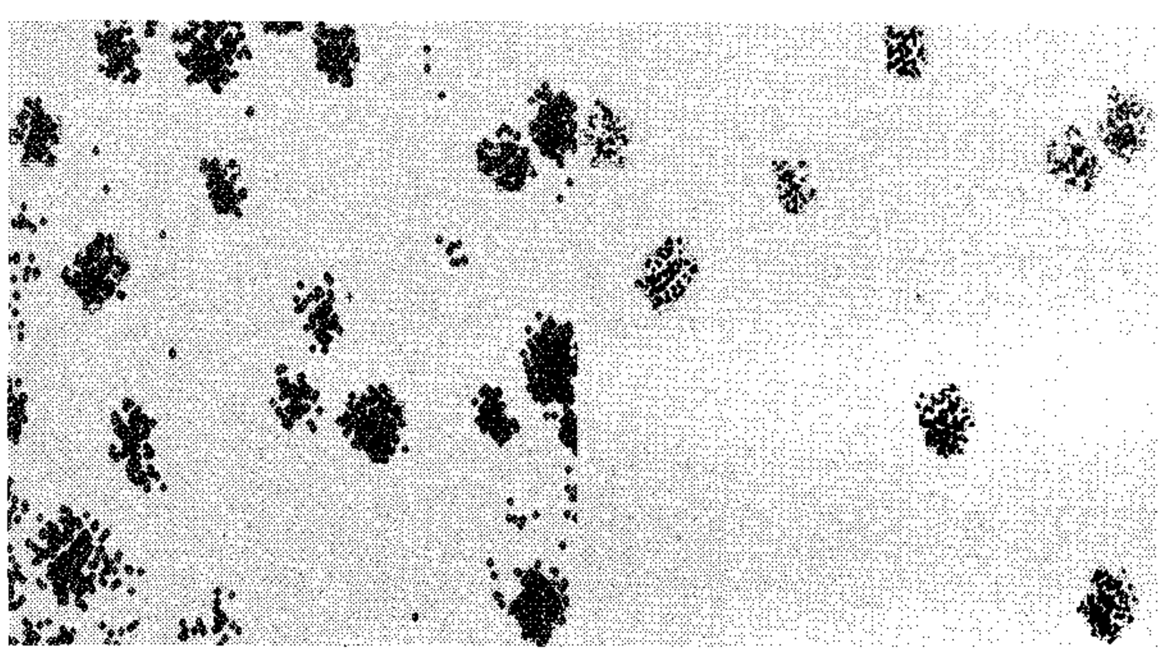


Figure 4. Identification of individual tree through morphological operations



a) Original LiDAR data (point density: 2.590 point/m^2)



b) The crown density imagery of individual tree
Figure 5.

4.2 Measurement of Crown Density

The LiDAR point data of individual trees were counted using by converted vector formats(Figure 5). Figure 6 show the crown density of broad-leaved tree and coniferous tree. The crown density is high coniferous tree more than broad-leaved tree.

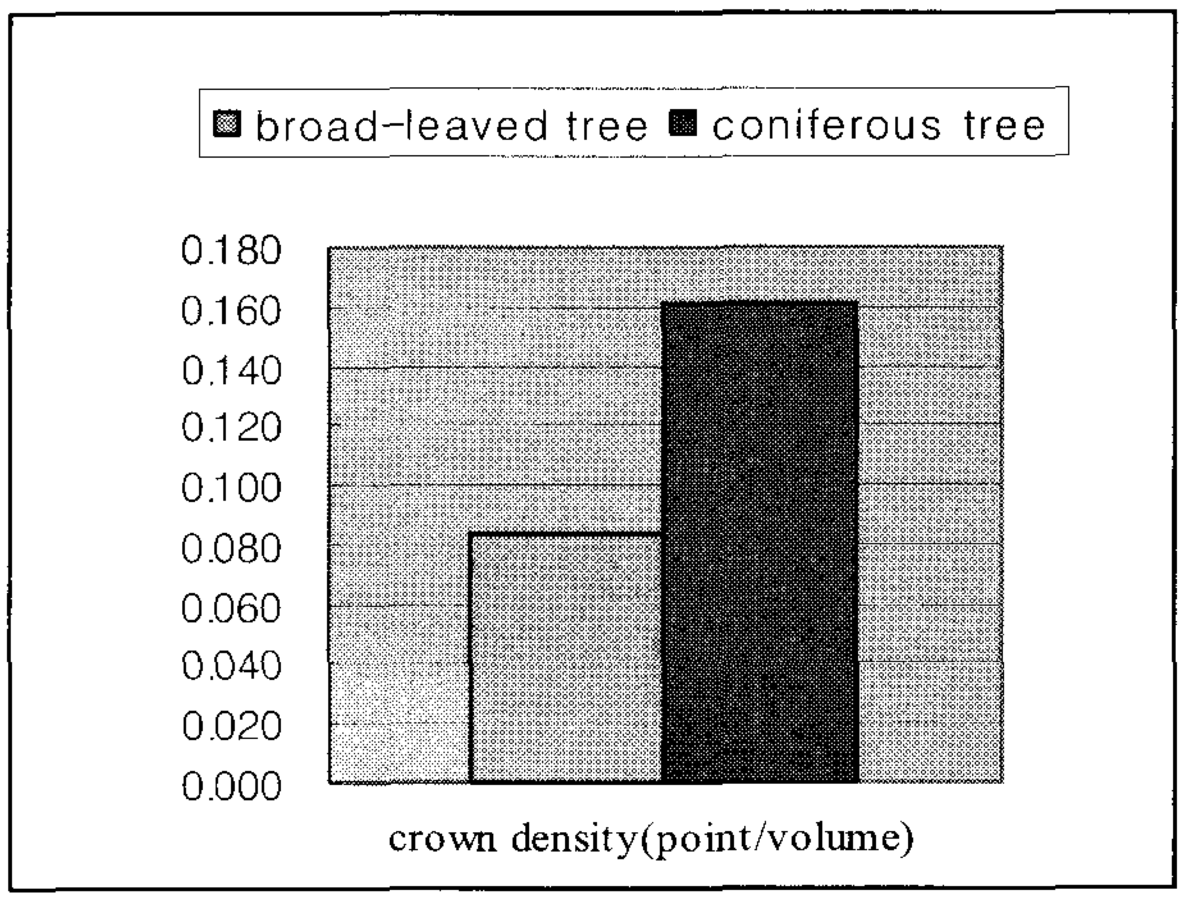


Figure 7. The crown density of broad-leaved tree and coniferous tree

4.3 Estimation of Canopy Parameter

The result of study show of comparing formfactor values with roundness(Figure7).

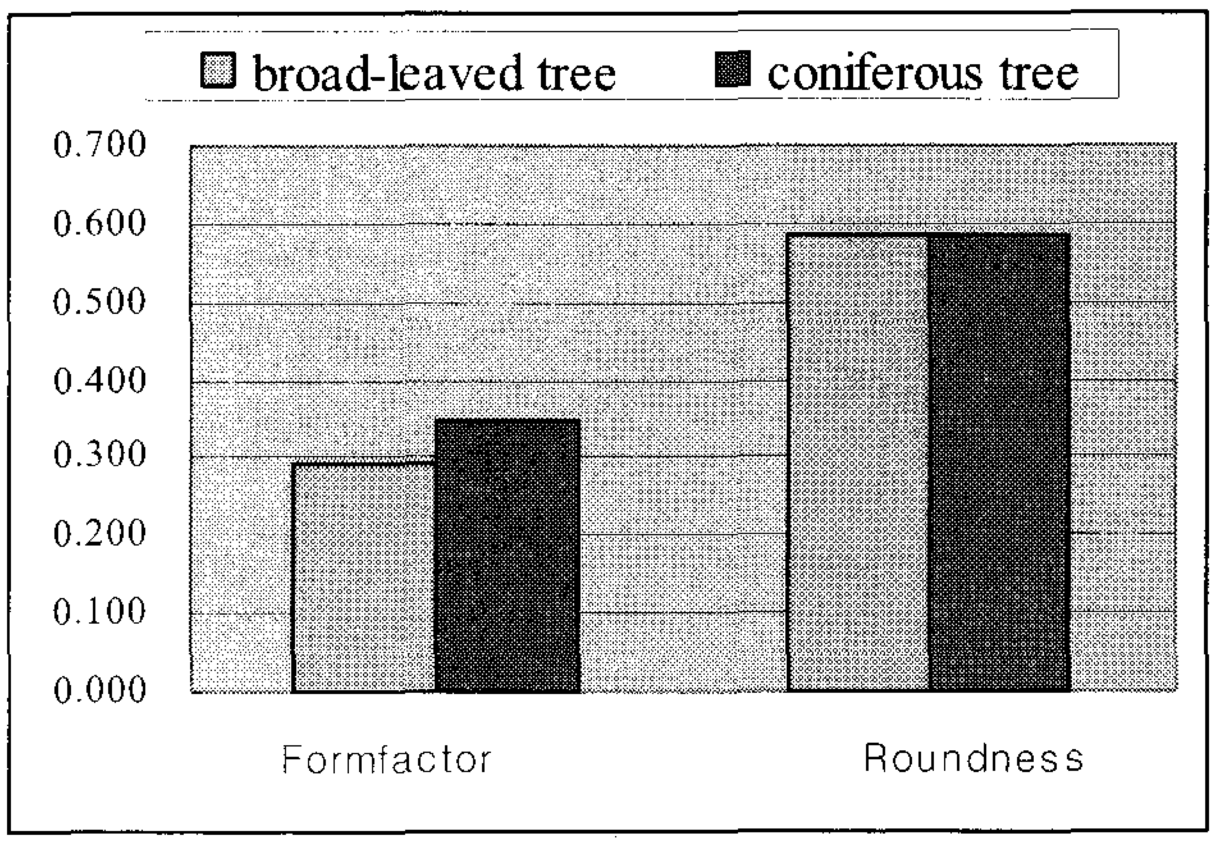


Figure 7. Histographic representation of comparing fractal dimension values with formfactor values for each 10 sample individuals in coniferous trees and broad-leaved trees of Kwangneung Experiment Forest

5. CONCLUSION

This study showed that LiDAR data can be used to detect and characterize vegetation in Kwangneung Experiment Forest. However, the crowed forest areas can not be extract individual tree. And the results of the current study show that LiDAR data could be used to estimate the average crown diameter and to improve extracts of other individual tree characteristic. Further study is needed to relate these measurements to field-based tree measurements.

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