

A New Method for Individual Tree Detection Using Airborne LiDAR Pulse Data

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1. INTRODUCTION

- Airborne LiDAR (Light Detection and Ranging) is possible to retrieve three-dimensional information about individual tree shape.
- Three-dimensional tree crown shape is important data source to 3D modeling, forest fire, forest hydrology, forest growth models, and so on.
- Most of the studies use the gridded data (Digital Surface Model, Digital Elevation Model and Digital Canopy Height Model) which are generated by LiDAR pulse.
- Accurate three-dimensional tree crown shapes can be retrieved by raw LiDAR data.

The objective of this study is to develop a method to detect individual tree crown using raw LiDAR data in coniferous forest.

Shichinohe, Aomori
Northern part of Japan



Fig.1 The study area

Table.1 LiDAR Sensor specification

| | |
|-----------------|-----------------|
| Sensor | ALSS50 |
| Flight altitude | 1829 m (Ave) |
| Date | 11, 12 Aug 2004 |
| Pulse rate | 46 kHz |
| Footprint size | 0.47m |



Cryptomeria japonica D. Don (Japanese cedar; Sugi)

Fig.2 Pictures of the study area

2. METHOD

Crown shape model By Sheng et al. (2001)

$$\frac{(Z + ch - Zt)^{cc}}{ch^{cc}} + \frac{((X - Xt)^2 + (Y + Yt)^2)^{cc/2}}{cr^{cc}} = 1$$

$$Zt - ch \leq Z \leq Zt$$

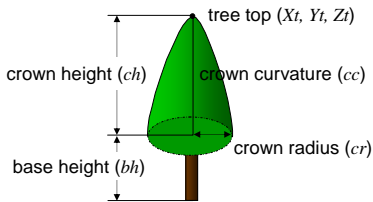


Fig.3 Parameters in the tree shape model

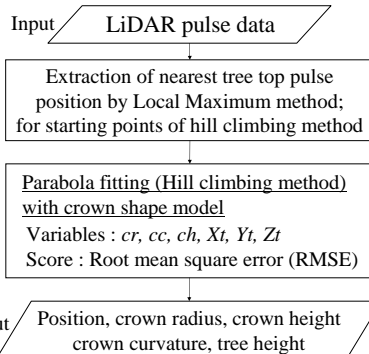


Fig.4 Flow chart for tree crown detection

Detail procedures for the tree crown detection

1. The pulses which are the "Nearest" tree top position are extracted by Local Maximum method.
2. The pulses which represent a tree crown shape are sampled around the nearest tree top pulse position.
3. Tree crown shape parameters (cr , cc , ch) are moved to neighborhoods. The RMSEs are calculated.
4. Position of "nearest" tree top is moved to neighborhoods, and the step 2 and 3 are repeated.
5. The model which has the lowest RMSE is determined.
6. Ground elevation is determined from pulses penetrated the ground. The tree height is determined.

3. RESULTS

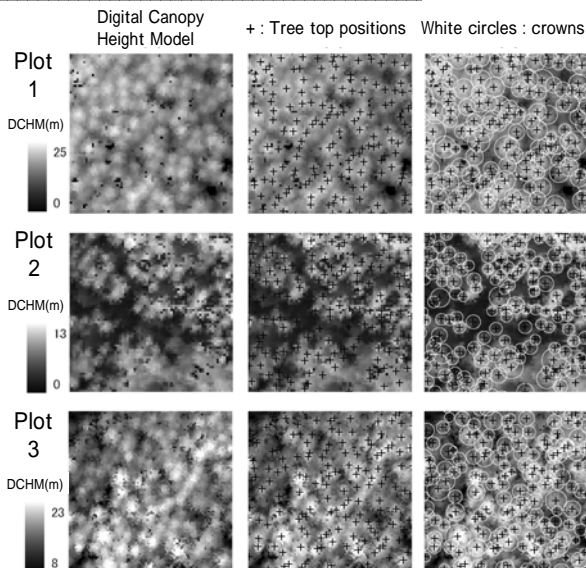


Fig.5 Detected tree positions and crowns

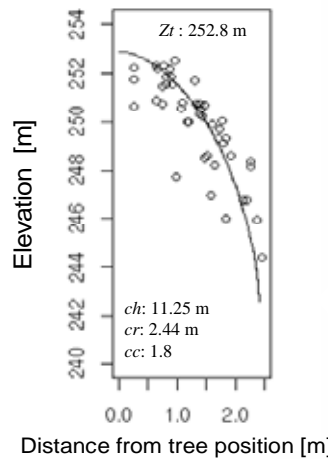


Fig.6 Scatterplot of sampled pulses. The line curve shows fitted model.

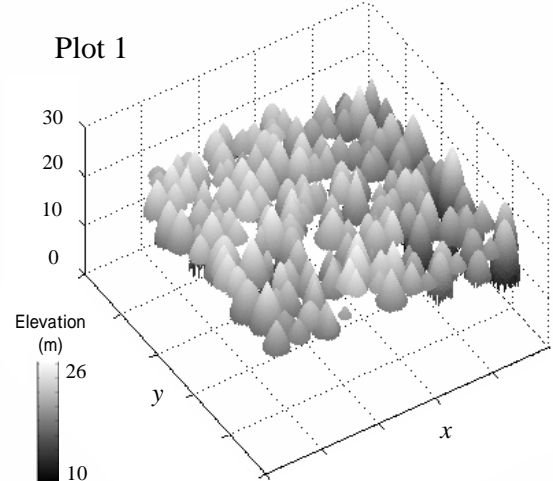


Fig.7 3D view at the part of plot 1. Each tree was rendered on flat surface.

4. EVALUATION

Table.2 The number of detected trees

| | Detected trees |
|--------|----------------|
| Plot 1 | 81.8 % (90) |
| Plot 2 | 73.3 % (126) |
| Plot 3 | 68.4 % (81) |
| Total | 74.4 % |

- Each field tree which was within cr and closest to the detected tree positions was linked.
- Most of undetected trees were probably suppressed.

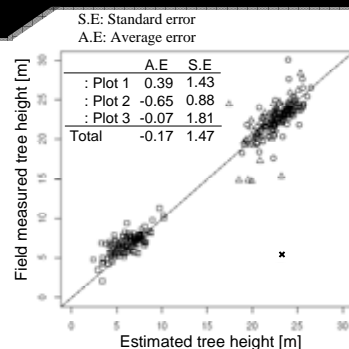


Fig.8 Scatterplot of estimated tree height against field measured tree height.

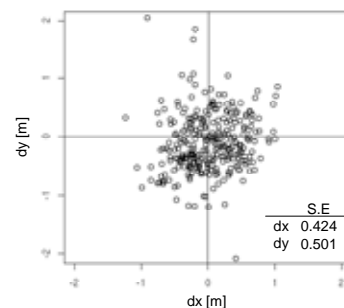


Fig.9 Positional differences of estimated tree positions.

5. CONCLUSION

- New individual tree crown detection method was developed.
- This method used not DSM & DEM but original raw LiDAR pulse.
- This method worked well for conifer forest.
- Quantitative evaluation of tree crown shape is out future task.