

TREE MODELING WITH DSM DATA

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Abstract: This study aims to resolve the problem of not being able to directly examine forests or each individual tree of a forest. In order to get the specific information on actual trees. Such as their locations, heights and the number of trees. We used an aerial photograph that is 4096x4096 pixels. And process the DSM/DEM data with a raw 16 bit-‘unsigned short’ data value. Through the collected information, we might model trees and a forest.

1 INTRODUCTION

Tree modeling refers to acquiring important information on trees such as location, height, width and the number of trees. LiDAR (Light Detection And Ranging) is a space information acquiring technology where many laser pulses (70 KHz) are shot from a plane and the reflected laser pulses are used to acquire high definition height information of the surface to create an accurate model of the laser. It is a new measurement technology that can be used to acquire high quality 3D digital data. Tree modeling with LiDAR data will increase efficiency when designing golf courses with lots of trees. This study introduces a solution to not being able to directly examine or explore forests and each individual trees by using an 4096X4096 aerial photograph and processed DSM/DEM data with a raw 16 bit-‘unsigned short’ data value a tree modeling method.

2 PREVIOUS STUDIES

Tree modeling has previously been studied in a variety of different ways in the field of remote sensing. First, there was the study where a sectional maximum filter was applied to a certain band and the satellite image resolution value was used to predict the central point of trees. There was also the study where an aerial photograph and LiDAR data were converged and a division method was used to estimate the height of each tree. Although both these

methods provided adequate solutions, they failed to provide a way to isolate and explore individual trees within the data collected.

3 METHOD AND RESULTS

Figure 1 shows the process for tree modeling used in this study. Previously, three parameters were produced for modeling purposes location, height and the number of trees. We expect to be able to enhance the existing modeling techniques to be able to differentiate the kinds of trees such as broadleaf or needle leaf trees. Our method consists of 4 major stages; First, extraction of areas where there are predicted to be trees; second, calculation of eigen value; third, elimination of errors in division; fourth, division of basin.

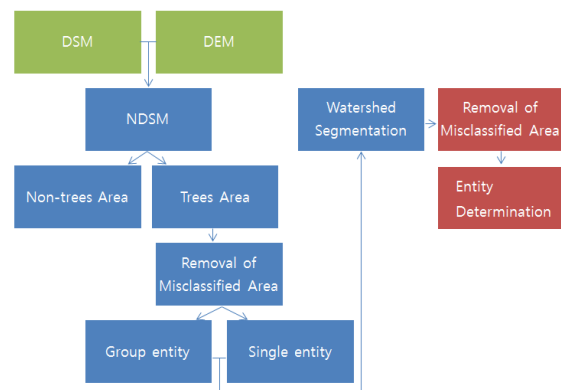


Figure 1: Tree modelling process.

The tree modeling uses DSM input data that consists of a raw data value that is a 16 bit – ‘unsigned short’ value. The entered DSM data is used to establish an image pyramid, as shown in Figure 2.



Figure 2: Image pyramid.

If an image pyramid as shown above is used, areas where trees are expected to be found can be sought out in advance from a smaller image. Then, when the smaller image is used on a higher level, areas that have already been processed will not go through the process of finding areas with trees. This process will result in increased processing speeds and enhanced image data.

$$f(u, v, \sigma) = \frac{1}{2\pi\sigma^2} \exp^{-\frac{(u^2+v^2)}{(2\sigma^2)}} - \frac{1}{2\pi K^2\sigma^2} \exp^{-\frac{(u^2+v^2)}{(2K^2\sigma^2)}}$$

Figure 3: Difference of Gaussian.

Areas expected to have trees are found using a DoG (Difference of Gaussian) filter with curve characteristics as shown in Figure 3. From the image that goes through DoG filtering we then look for a sectional maximum value or minimum value. The image is a 16 bit height map, so exceptionally higher or lower values than the surrounding areas are extracted for areas with trees.

The top left block of Figure 4 shows part of a color aerial image, and the top right is the DSM data with a 16 bit height value that will be used for tree modeling. The DSM data is used to calculate a normal vector and create a visual presentation, and the screen shot shown on the bottom left block is gained. If a DoG filter is applied to the DSM data, an image as shown on the bottom right appears. The bright area in the center is the sectional minimum value at [-65535, 0], and can be evaluated as the location of trees. In addition, a simplified box filter as shown in Figure 5 can be used instead of a Gaussian filter for increased speed.

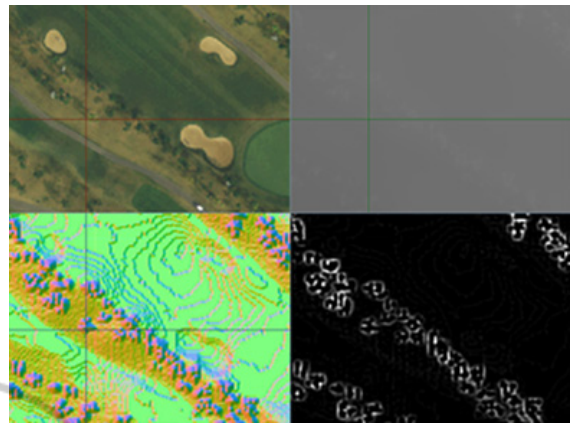


Figure 4: Visual presentation of areas expected to have trees.

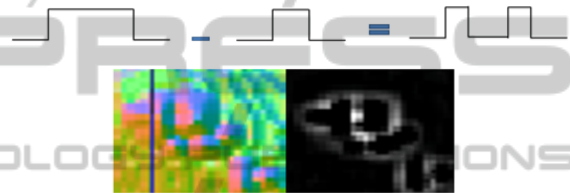


Figure 5: DoB (Difference of Box) results.

The location of trees is predicted by using the sectional maximum or minimum values of an image after it has gone through the DoG or DoB filters, so creating a visual presentation of the predictions leads to the image shown below in Figure 6.

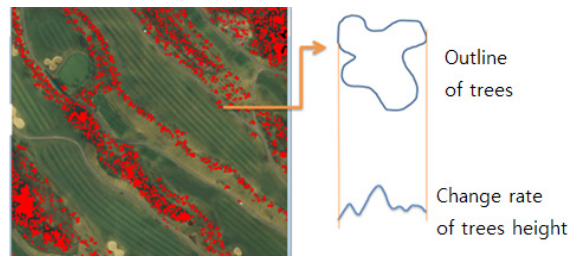


Figure 6: Sectional maximum/minimum values.

The red areas in Figure 6 are areas predicted to have trees. It shows both groups and individual trees. The area is classified to be a group area when the red area is greater than a predefined width. After this processed, a watershed algorithm is applied to divide it into individual trees. If the divided area is less than a predefined minimal width, it is classified as a single tree, and the process of finding out what type of tree begins.

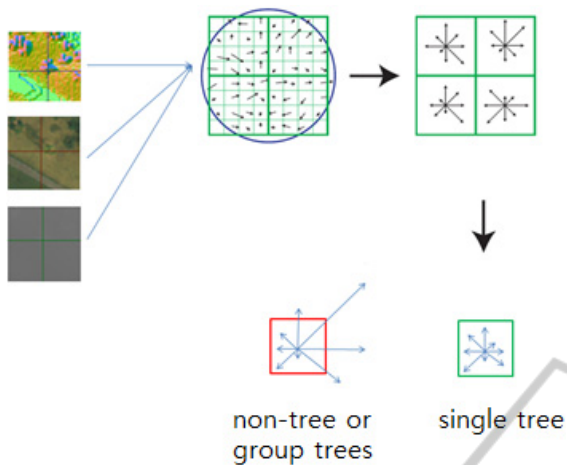


Figure 7: Classification of single tree and group trees.

4 CONCLUSIONS

An aerial photograph 4096x4096 in size and processed DSM/DEM data with raw data value that is a 16 bit-'unsigned short' value were used in this study for tree modeling. This study used a 4096X4096 photo, processed DSM/DEM data, and a raw 16 bit-'unsigned short' data value to create the tree model. The process involves extracting areas expected to have trees, and applying a basin division algorithm is to extract results for tree modeling, but stopped before identifying the type of tree. The proposed process is largely divided into 4 steps- : extraction of areas expected to have trees, eigenvalue calculation, elimination of errors in division, and division of basin. The information on trees gained through this process is used to output Figure 8 as a result.

The four processes proposed in this study are used to gain important elements for tree modeling, with the exception of identifying the type of trees. Figure 8 has a random tree type because a specific tree type analysis was not conducted. Tree modeling may be improved in the future through studies on identifying the type of trees.

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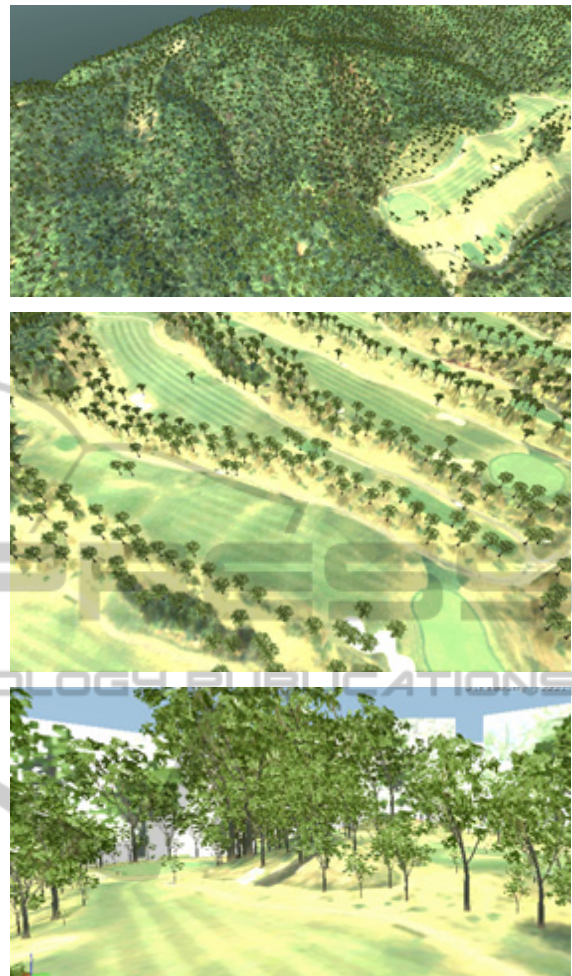


Figure 8: Results output.

REFERENCES

- M. A. Wulder, J. C. White, K. O. Niemann, T. Nelson, 2004. Comparison of airborne and satellite high spatial resolution data for the identification of individual trees with sectional maxima filtering. *Taylor & Francis* vol 25.
- Juan C. Suarez, Carlos Ontiveros, Steve Smith, Stewart Snape, 2005. Use of airborne LiDAR and aerial photography in the estimation of individual tree heights in forestry. *Computers & Geosciences* 31.
- Timothy L. haithcoat, Wenbo Song and James D. Hipple, 2001. Building Footprint Extraction and 3-D Reconstruction from LIDAR Data. *IEEE/ISPRS Joint Workshop in Remote Sensing and Data Fusion over Urban Areas*.
- Jean Cousty, Gilles Bertrand, Laurent Najman, and Michel Couprie, 2010. Watershed cuts: thinnings, shortest-path forests and topological watersheds. *IEEE Transactions on Pattern Analysis and Machine Intelligence*.

Geun-sang Lee, Deok-gu Koh, Hyo-seok Chae, Young-ho Shin, 2003. "A Comparative Study on DEM Errors According to Resolution of Aerial Laser Measurement Material," *Korean Geographical Information Society Journal*.

Open Source Computer Vision Library Reference Manual, Intel., sourceforge.net/projects/opencv/.

Imagirae Takashi. *DirectX 9 Shader Programming*. Seoul: *Hanbit Publishing*.

