AN AUTOMATIC METHOD BASED ON GRIDDING SEGMENTATION FOR TREES' CLASSIFICATION IN FORESTED AREAS

Chunjing yao [a, *], Hongchao ma [a]

[a] School of Remote Sensing Information Engineering,Wuhan University
Luoyu Street 129, Wuhan city, Hubei Province, P.R.China-
silenrain55@126.com

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ABSTRACT:

In forestry applications, the great challenge is to automatically extract as much information as possible on forest structure, the vertical and horizontal distribution of vegetation, the delineation of individual trees and identification of their species. Lidar data has great efforts on forest application because of its precisely 3d Geometry information. In the current papers, the methods mainly focus on individual tree's classification in urban areas or manage the forest area as a whole. In the original techniques, it is difficult to extract two or three trees which grow together. The new method proposed in this paper can solve the problem rightly, which is based on the gridding segmentation, which can both extract individual trees and classification. The method in this paper is also an automation process for vegetation further classification and it includes five steps: location, segmentation, statistic, analysis and further classification. In the test area, we should distinguish at the individual tree level between Conifer (pine trees) and Broad-leaved (poplars). While a clear distinction between these two species was not always visually obvious at the individual tree level, due to other extraneous sources of variation in the dataset, the observation was supported in general at the site level. Sites dominated by Conifer exhibited a lower proportion of singular returns compared to sites dominated by Broad-leaved, and the method can distinguish the sorts of the trees in the test area and each sort has a 70% correct classification.

1. INTRODUCTION

Airborne laser scanners provide accuracy, speed and ease of deployment, and which are classified as active digital sensors(Kristian Walker Morin, November 2002). Given its application proximity to photogrammetry, it is clear that one of the primary uses of LIDAR systems would be to generate surface terrain models. LIDAR observations can have much more dense point spacing than is typically derived from photogrammetry, with current systems abilities exceeding 1 point / metre. In recent years, the use of airborne Lidar technology to measure forest biophysical characteristics has been rapidly increasing. Lidar data availability has grown exponentially during the last decade, and it appears that in future years this trend will likely continue. In particular, the development of sensors with increased sampling rates is likely to make future acquisitions of high sampling density datasets cheaper. High sampling density lidar data is potentially beneficial for a wide range of traditional and new forestry applications. Its importance comes from its capability to accurately estimate vegetation structural attributes of a forest canopy.

It is the unique ability of laser scanning to measure ground elevation directly, most often through penetrating the tree canopy; that is one of the major advantages that lidar offers over traditional photogrammetry when operated in forested areas. In this paper, we will classify the laser points using their echo information, for the vegetation is commonly be sensitive to the echoes. Over recent years, scanning lidar instruments have advanced from recording the first and last return amplitudes of the backscattered laser pulse to newer instruments that record up to five or more multiple returns from each pulse, or record the complete waveform of the pulse reflection.

2. PREVIOUS WORK

2.1 The study of the data composition

In the test area, we should distinguish at the individual tree level between Conifer (pine trees) and Broad-leaved (poplars). While a clear distinction between these two species was not always visually obvious at the individual tree level, due to other extraneous sources of variation in the dataset, the observation was supported in general at the site level. Sites dominated by Conifer exhibited a lower proportion of singular returns compared to sites dominated by Broad-leaved.

2.2 data preparation

In this paper, we mainly focus on the trees' classification on the vegetation layer. Of course in the first step, we must extract vegetation points from the whole laser points, which include high vegetation points and low vegetation points. The high vegetation is defined for the tree classification. There are two test areas for the study—one area has relatively sparse trees and the other can be seen as a forest. Then we use the gridding segmentation method to classify the trees and get the information of the tree vegetation simultaneously.

* Corresponding author. silenrain55@126.com; phone 0086-027-68778081

2.3 Previous Definition

Firstly, a gridding segmentation is defined which is a mathematical notation for different types of groupings of the laser points. In the gridding segmentation method, we divided the area into a number of plots (the sizes of the plots are comparable to the single trees), then in order to get more detailed information, we subplot the area according to the needs of the application.

For the extraction of the penetrability, we must be informed that: (1) a single return with only one recorded amplitude peak, (2) the first return of a double return with two amplitude peaks, (3) the second return of a double return with two amplitude peaks(T. Moffiet etc 2005). And the echoes contain three characteristic:

a. The count of first returns should balance approximately with the count of last returns.

b. The count of last returns from vegetation should be less than the count of first returns from vegetation, since many of the last reflections are from the ground, not vegetation, and are included in the last return ground file.

b. The count of last ground returns should be greater than the count of first ground returns. For direct ground hits a first and a last return are recorded together. In addition, a last return ground hit is included when it follows a first return vegetation hit (Tomas Brandtberg, 2007).

In the classification process, we make full use of the echo property for the vegetation, because the echo information is more sensitive for the trees. From the two figures below, you can find that obviously.

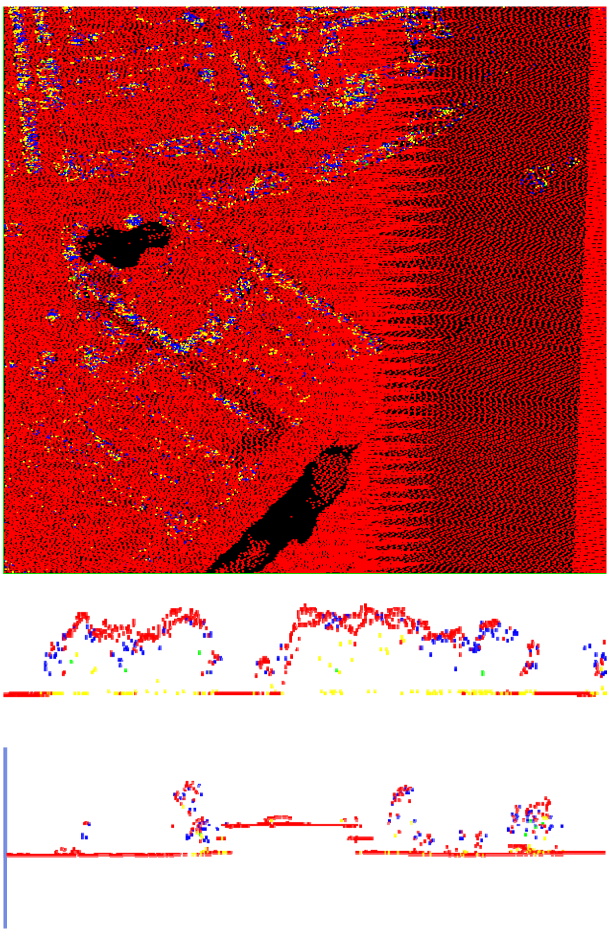

Figure1. Different echos data. red: only echo ; blue: first of many; green: intermediate of many; yellow: last of many;

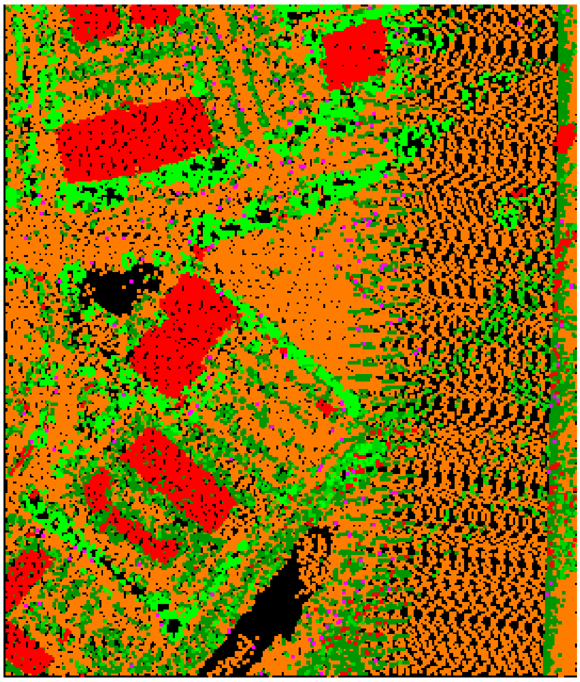

Figure2. Classified data. Red: buildings; virescence: high vegetion; orange: ground; purple: low points.

2.4 Pre-Classification

For the test area, most of the data was covered with the forest areas. In order to classify the species of the trees, the first step was to graphically inspect the raw data for outliers that could be considered to be errors of data collection or processing. In the second step, we must classify the land points and non-land points (mainly the vegetation points). Then we can define the layers as land layer and vegetation layer separately. As figure3

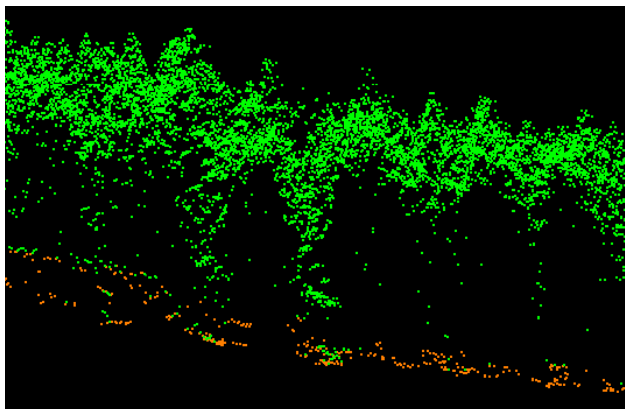

Figure3. The result of pre-classification. The green stands for the vegetation and the brown stands for the land .

3. FURTHER CLASSIFICATION

3.1 Location

In order to speed the processing, we plot the point into grids, which have the comparable size of the individual trees. Then subplot the grids into smaller size, then calculate the number of the points in the subplots, if the subplot which have the least number of the points in the land layer but have the most number of the points in the vegetation layer in one grid, then we can get the coarse location of the tree, and call the subplot subplot1. In the contrary, we can get the subplot2 which have the least number in the vegetation layer and the most number in the land layer.

In the first test data, which has sparse trees, we usually plot the points in the first grid layer level, then calculate the density of the points in each grid, and the average height of the points. The more dense and higher grid can be defined as the location grids of the trees.

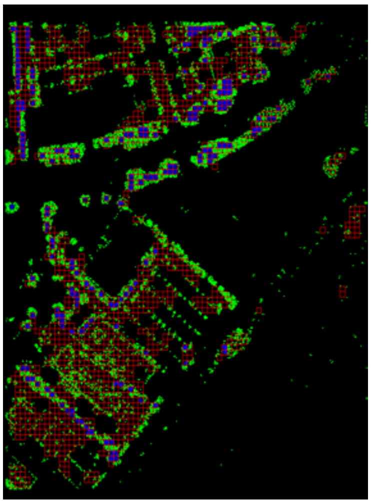

Figure4. Blue is the location of the trees in the first test data

But for the second test data, there are more trees and many trees are growing together. So we must subplot the grid in order to get the tree location more precisely.

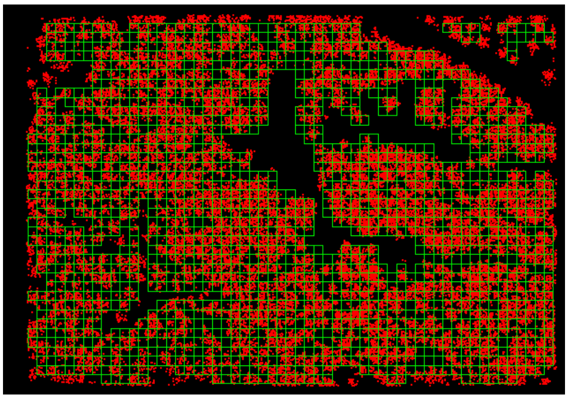

Figure5. The locations of the trees(red) in the second test data

3.2 Segmentation

Calculate the neighbouring subplots of the same attributions which satisfy the conditions above, the distance between the subplot1, then adding the subplot2 between the neighbours and the height information of the points in the subplot, we can get the contours of each tree, then the segmentation is finished. This step is applied to the second type data.

3.3 Classification

After the segmentation of the individual trees, the features were related to the characteristics of the crown structure and shape, dependent on identification of individual trees, as well as non-shape measures that is derived directly from the laser data such as the return intensity and proportions of the different types of laser returns. Extracting the information from the segmented data through exploratory data analysis is a necessary first stage of data analysis particularly for observational data. The exploratory data analysis is used to assess the potential of laser return type, return densities, penetrability and geometry characteristic as variables for classification of individual trees or forest stands according to species. For narrow footprint Lidar instruments that record up to two return amplitudes for each output pulse, the density and penetration has discussed above. The importance of geometry information for species discrimination will be presented in the following: Despite this apparent confirmation, we can get the height of each tree by measuring the top of a tree and the ground (usually the Z value of the location point in the first echo). The range of the crown can be calculated. Then added up all the information, clustering analysis method is used to classify the trees.

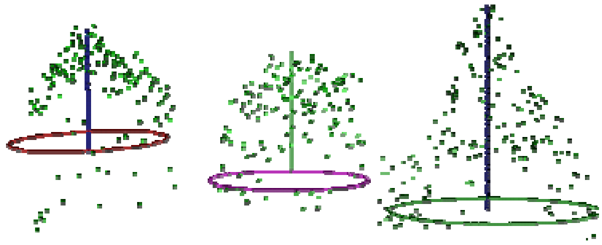

Figure 6: 3D Geometry Information

In some cases, two or three trees may stands together, the subplots allowes us to get the first three most penetrations, and then if the three heights of the tree are comparable, the two or three can be extracted individually. In this way, the count and the locations of each kind of the trees in the area can be maintained. Then the heights of the trees, the volume of the forest and the classification of the trees can be attained automatically.

4. CONCLUSION AND FURTHER WORK TRANSMITTAL

Compared to most of the current methods, the technique is more simple and efficient. But to some disadvantage, they must be used to some high density data, if not, the result may appears disappointed.

The size of the plot must be comparable to the average size of the trees, or else there may be some confusion in the result of each plot.

The information extraction depended on the segmentation processing. The penetrability can be replaced by the number ratio of the subplot, and the radio of the crown width and the height, both of the two factors are between the 0 and 1, we can exchange it to 0-100, then the clustering Analysis method can be used to classify the trees in the forest.

In this paper, the tested area has mainly two kinds of trees, and in the further work, we will try to extract more information and to classify more complicated areas.

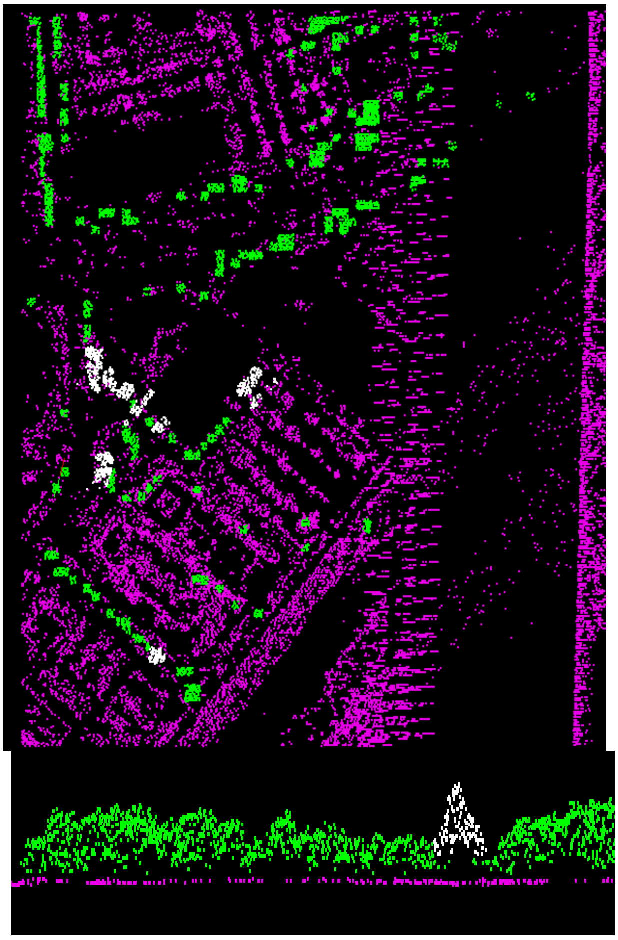

Figure 7.Result of the classification

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