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Lidar data reduction for preparing map data at 1:2000 scale. A case study in Ho Chi Minh City

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Abstract

This research reports how to reducing high density and big volume lidar data to 1:2000 scale map data. The research summaries some processes on lidar data reduction and applying in Ho Chi Minh city. Two kinds of location are studied: the airy field and the narrow housing places. The results of the research is the set of elevation points for 1:2000 city map

Keywords: Lidar, reduction, topographic map, base map

1. Introduction

Lidar data are big volume and are acquired by laser system on aviation. With high point detisny, about 2.5 points/met square, the lidar model is details. And the computation time is longer and the data volume is biger for application. In addition, more detail in DEM may caused errors due to the data do not reflect all terrain but they may contain many other objects on the ground. To solve this problem as well as making the computing faster, the reduction of lidar data needs. Actually, although data in scale 1:2000 have less density then lidar data, having efficiency in some processings and applications. In principle, the reduction need to reserve the key elements and filter the less important of the terrain forming points.

In this research, the lidar reduction for two areas in which features are housing and bare land. The data reduction is made for the map responding to the scale 1:2000.

2. Methodology

2.1. Data and study area

Two reseach areas are wide 1kmx2km at Tân Thới Nhất and Tây Thạnh Ward in District 12, HoChiMinh city. And the data are digital terrain model (DTM) in text ASCII in two files DTM_348196_A1.txt and DTM_348196_B1.txt. Data are obtained by the lidar project for 3-D model for urban management in HoChiMinh city. The project was been made by HCMGIS (Center for Applied GIS of HoChiMinh city – belongs to Department of Sciences and Technology) from Feb 2012 to May 2012. Besides, the base maps include road, ward, district and all in VN-2000 projection.

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Fig. 1. Study area and lidar data in HoChiMinh city

2.2. Reduction theory

In theory, data reduction may be in 3 groups:

- Type 1: Random point reduction.
- Type 2: Grid resolution reduction
- Type 3: Combined data reduction (type 1 and type 2).

In addition, according to the state in normative of mapping scales 1:500, 1:1000, 1:2000, 1:5000, 1:10000 and 1:25000: the average error values of objects location on the map compare to nearest control points (on the plan) must follows below rules:

- 0.5mm for mapping on the while mapping in the delta and mountain areas.
- 0.7mm for mapping on the while mapping in the mountainous areas and mountain.

Therefore, for the one-metter resolution lidar data, the plan accuracy is checked and guaranteed for building map in scale of 1:2000 in HoChiMinh city if the accuracy will be less than 1.0 metter.

Table 1. The regulation for topographic map scale of 1:2000 (outdour section)

Map scale	v (degree)	Contour interval (m)	MSE (mm)
1:2000	0 < v < 2	0.5	125
		1.0	250
	2 < v < 6	0.5	166.7
		1.0	333.3
		2.5	833.3
	6 < v < 15	2.5	1250.0
	v > 15	2.5	1250.0

In reality, LiDAR data have 3 points per metter square, accuracy less than 0.35mm on the map scale 1:2000. The accuracy 0.5m is the error bound of the height with the probability 95% (equal to 2^{σ}) and MSE for the height about 0.25m. Since then, we have the maximun distances between the points in the map scale of 1:2000 is 40 metters. And this below is the calculating process:

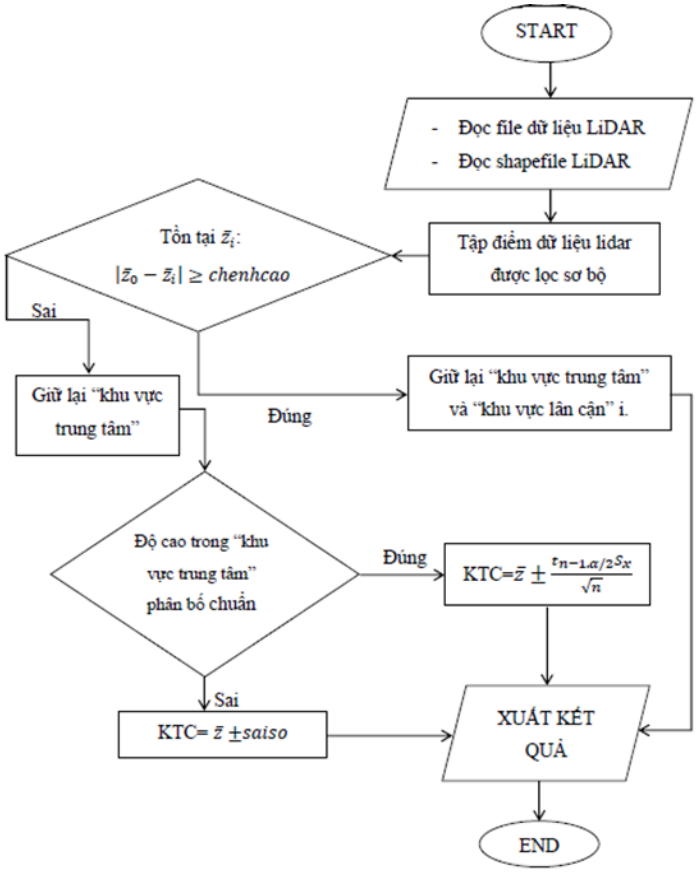

Fig. 2. Scheme for the algorithm

- The formulas for the center which normal distribution:

$$\bar{z}_{kvtt} - \frac{t_{n-1,\alpha/2}S_z}{\sqrt{n}} < Z < \bar{z}_{kvtt} + \frac{t_{n-1,\alpha/2}S_z}{\sqrt{n}} \quad (1)$$

- The formulas for the center which not normal distribution:

$$z_{tb} - sai\ so < z < z_{tb} + sai\ so \quad (2)$$

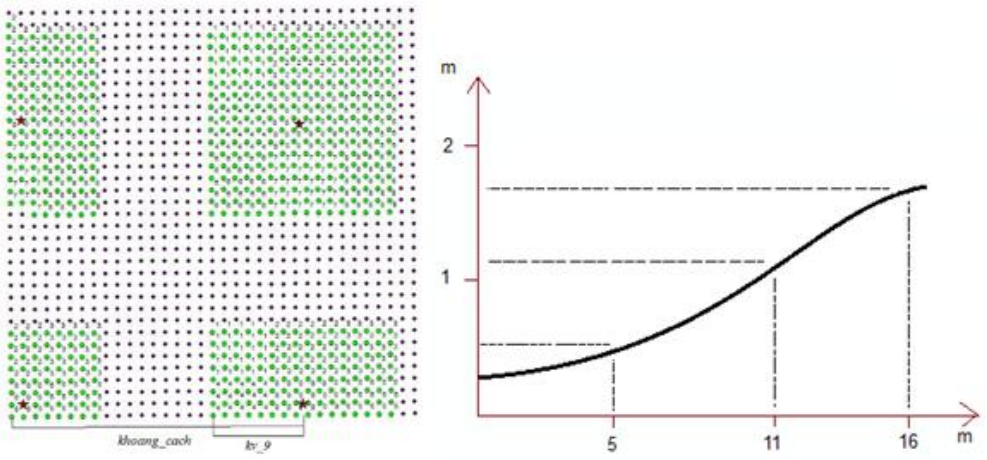

Fig. 3. The location and 08 neighbor by distance (5m, 11m and 16m)

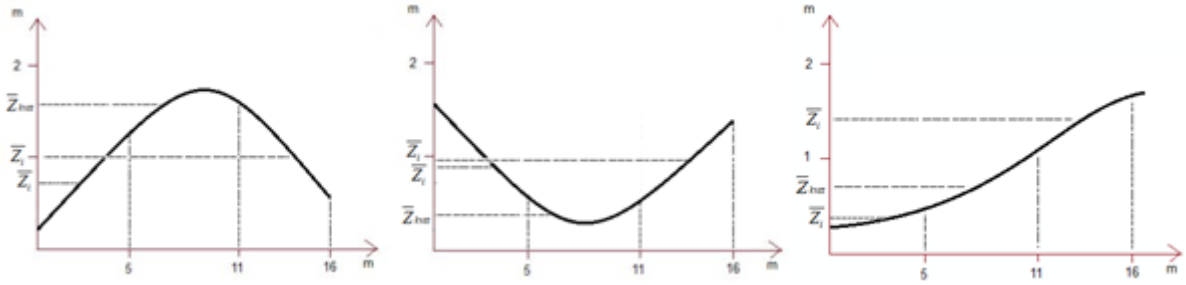

Fig. 4. 03 cases for argumentation

Accordingly, the rule of selection for the points spacing 8-to-10 metters with others and under 0.5 metter height difference will retain the feature of nearly flat terrain as in HoChiMinh city. Besides, we could use the map to elemimate points located in the houses or on the hydraulic system. Because within the distance of 20 metters, the terrain features is kept for the map scale 1:2000. But that will not true if the distance over 30 metters.

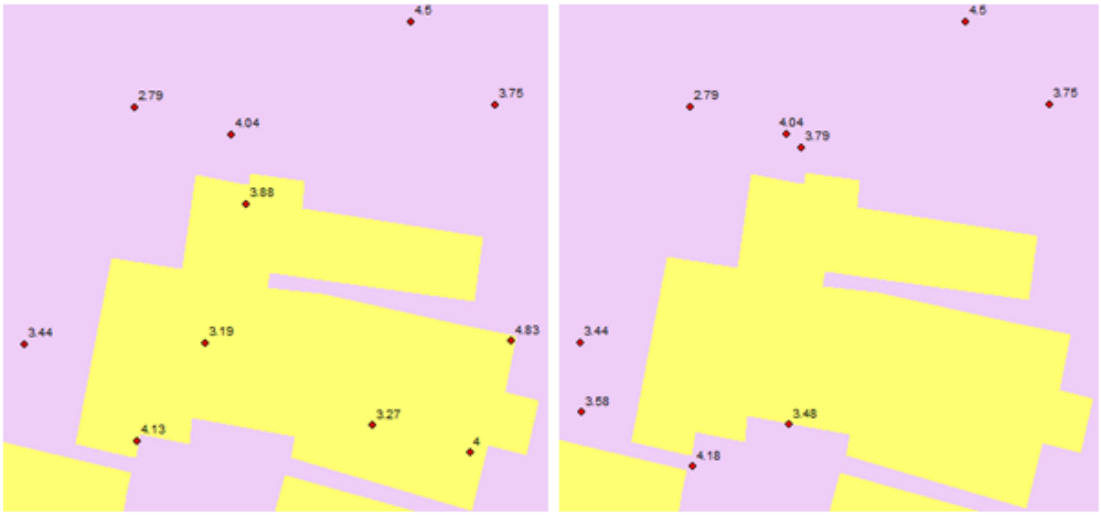

Fig. 5. Adding the parcel layer and remove/replace the points in parcels

3. Results and conclusion

After filtering the points, we can establish the TIN model for testing purpose. Below is the TIN creation of two set of data: the 1:2000 scale map points and the reduction lidar point into 1:2000 map in the study area.

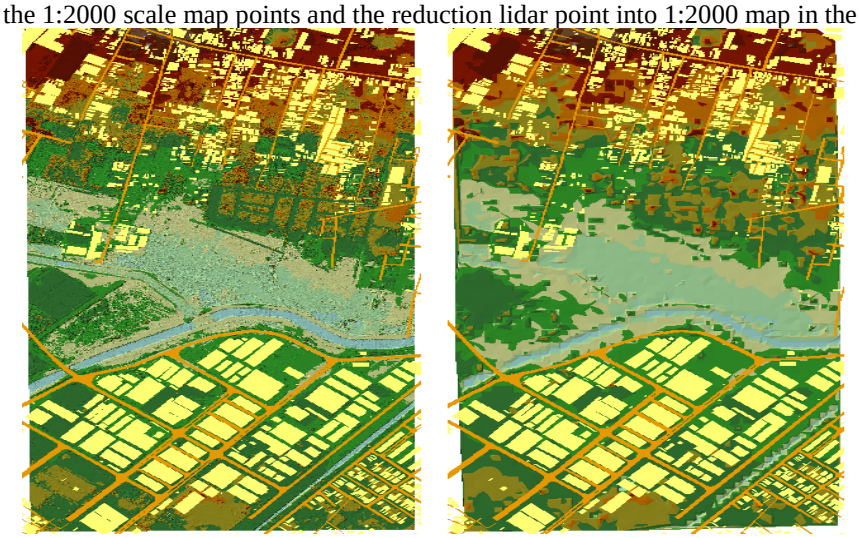

Fig. 6. 2 TINs conparison

Next, the data quality is estimated by comparison the values by interpolation and the 1:2000 map:

id	X(m)	Y(m)	$H_{đo\ cao}$ (m)	$H_{nội\ suy}$ (m)	ΔH
1	594066.860	1197419.910	3.94	4.13	0.19
2	594893.510	1197720.970	5.13	5.33	0.20
3	594768.370	1197200.120	3.50	3.24	-0.26
4	594493.000	1196849.140	1.58	1.78	0.20
5	594725.830	1196325.930	2.46	2.73	0.27
6	594249.300	1196000.470	3.42	3.25	-0.17
7	594173.480	1196655.810	3.29	3.64	0.35
8	594771.210	1196002.310	3.15	3.18	0.03
9	594919.890	1196584.330	2.06	1.75	-0.30
10	594262.630	1197040.410	3.10	3.03	0.07
11	594339.93	1197404.93	4.36	4.61	0.25

All in all, lidar reduction for mapping is acceptable. This work may save the time, budget for the 1:2000-and-below map making. And we can improve and re-code the algorithm to get more:

- Remove anormal objects, such as: benches in school/park,… Filter the edge/corner point of house, streetm,…
- Using analytical methods to access topographical slope to retain the features of the terrain..
- Apply the optimization solutions, especially for computing the map in .
- Parallel the algorithm for speedy the algorithm.

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