A FLOW TO GENERATE DEM AND SEGMENT BUILDINGIN IN URBAN AREAS FROM LIDAR DATA

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ABSTRACT:
Based on the character of Lidar data，this paper presents a fusion arithmetic to abstract DEM，and presents a flow to get building data from the object data. Firstly, this paper preprocesses the range information and intensity information，fuses these two different kinds data, abstracts ground seed point，uses sub area surface fitting way to generate DEM. Then，using an improved connected component labeling algorithm to label the object data，according to the connectivity to analyze and segment the data, adopting mathematical morphology way to optimize the result. An experimental data is disposed by using the flow and algorithm，and the result proves it is feasible.

1. INTRODUCTION

Lidar（light detection and ranging）is a new technique to acquaint remote sensing data, Which can acquaint spatial data directly ， get DEM quickly ， and abstract building information，is a very important in some application such as foundation mapping and digital urban construction.

The data acquired by LIDAR technology are DSM (Digital Surface Model),which are not only contain the information of open ground, but also contain the information of object not in open ground, such as building, tree, electric line of force, vehicle, et al. To generate DEM and obtain construction data from Lidar point clouds is a hotspot and difficulty in Lidar research. The Lidar data processing method in existence always only use the range（elevation）information of LIDAR, and nearly not use other information, which gets less effect in large hypsography regions, and has low autoimmunization, and needs substantive handiwork to redact the data.

This paper will use multi information collected by LIDAR, and based on the theory of data fusion, let the spectral information and elevation each other, to form a new algorithm and flow of Lidar data processing.

2. PRESENT STATUS AND ANALYZING

There are approximately two kinds of filter algorithm at present. The first is based on the change of gradient and height. This algorithm hypotheses that the different between terrain gradient and ground object gradient is distinguishable, which means the different between the ground points and the ground object points such as the points on tree, building et al are greater than the different in the ground points. Volsselman designed a specific kernel function using such theory in 2000, and generated DEM by mathematical morphology operation [1]. Through order scan along the scan lines of LIDAR data, Shan marked ground point and object point by judging whether the different of gradient and elevation between neighbor points exceed threshold [2]. Because deciding the attribute of LIDAR points only by spatial relation of neighbor points, which leads to use the data in small scope, this type of approach has low reliability.

The way based on the shortest distance to a surface. Firstly, This algorithm constructs a initial surface, and judges the distance from laser foot point to the surface, if the distance greater than threshold, the point is belong to object point, otherwise, it is belong to ground point. Afterwards, the algorithm use the new ground points to construct new Demote proceed new estimation to determine new ground points. In this way the algorithm keep iteration, until satisfy given condition. Akel presented an algorithm in 2003, which is using road network to get initial DEM, and then get final DEM using iterative computation [3]. Hyun S.Lee（2003）improved linear prediction method, assembling linear prediction and adaptation processing technique to generate elevation model, obtained refined DEM [4]. The key of this type of algorithm consist in the selecting of initial surface. Some approaches can not get correct DEM because the seed point of initial surface wrong selected, which leads the initial surface overtop or too low. Because this kind of algorithm uses all data to calculation, it can avoid some part error points, but the huge calculated amount will expend substantive time.

We can get building information in the non- ground point. The key of get building information from Lidar data is to confirm and compose the map relation of one to many among the building and Lidar points. That means every building contains multi- Lidar points, and every Lidar point only belongs to one building. So, on one side, we must distinguish all the points which belong a building and give them a sane label; on the other side, we must ascertain which building one points belongs to if it is a building point. After get the map relation，we can using conventional photogrammetry approach to ascertain the building boundary and vectorizate it.

Based on multi- echo information, Abdullatif Alharthy（2002）presents a flow to abstract building information. Using the first minus last return analysis, Abdullatif get the regions of penetrable objects, and the information of the side of a building. Then removing the penetrable object region from the last return, the paper gets the building. By set threshold to elevation and area, the paper removals the non-building information such as vehicle and vegetation, and gets the building information [5]. Aparajithan wait（2004）use region growing method to abstract building from Lidar data set. Firstly, the paper get one constructional seed point. Then gradually detects and estimates the Lidar points around the seed point, and complete determinate all the points belongs to a same building [6].

This paper presents a LIDAR data filtering algorithm which is fusion multi information and can get ground seed point with high precision, then use blocking surface fitting way to reduce the relativity with window size. This paper presents a LIDAR data filtering algorithm which is fusion multi information and can get ground seed point with high precision, then use blocking surface fitting way to reduce the relativity with window size. To non- ground point data，firstly we establish the many-to-one map relation among Lidar points and building by label method，that is ascertain the attribute of every Lidar point, and using a unique flag value mark it. Then adopting mathematical morphology method to precision process the result，and get the accurate building information.

3. ALGORITHM DESCRIPTION

3.1 Flow frame

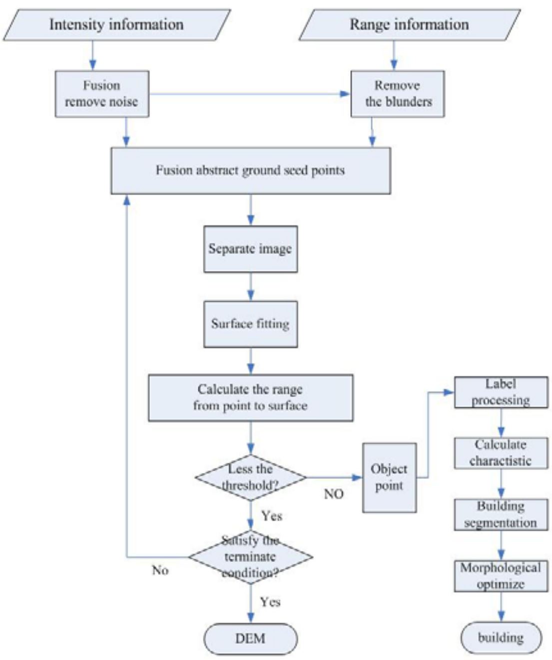


Figure 1. Process frame

3.2 Data preprocessing

To removals the blunders this algorithm firstly calculates the local statistical characterization of range information, removals the point whose statistical characterization is obviously different to that of it's around point. Then regularize the LIDAR data, resample the divergent data to regular data.

To dispose the intensity information, this paper firstly statistics the frequency, removal the point whose value is far greater than or less than its neighbor points' value, then proceeds resample. At last using fusion algorithm, this paper removal the error points in intensity information [7].

3.3 Abstract DEM fuse intensity information

(1) Get the seed points

The obtaining of seed point is vital in the algorithm which is use surface fitting and iteration to generate DEM. The quality of classification and distributive uniformity of seed point decides the success of the algorithm. This paper presents a new algorithm to automotive get seed points which is use all the intensity information and range information of LIDAR data.

Because we only need few open ground points as initial seed points, we only need guarantee every seed point is open ground point, and need not consider whether we delete some points which belong to ground point in error. So, we can restrict the threshold in a stern interval, so that we can guarantee the points are ground points whose intensity value in the interval. That is easy to do in the regions where cultural feature is few. But in urban area, because the cement floor, cement road have the same material as building, this method can not guarantee the precision of type I error. Because the hypsography is not very big in urban area, and the height value discrepancy is very large between the ground points and ground object points, we can introduce height as constraint condition. So, we can ensure the accuracy of the seed points, as well as guarantee the seed points equably distribute in whole area.

(2) Abstract DEM

This experiment adopts sub area way to fitting surface. We can consider the small region as a surface even a plane which has little hypsography, when the small is small enough. Then, we can adopt the principle of surface fitting to filtering the data in sub region. This paper uses the conicoid fitting process based on least square.

This algorithm use iterative approach as follows: firstly, take all seed points into surface equation, calculate an initial approximation, and figure out correction; secondly, plus approximation and correction as new approximation; then iterative computation, till the correction is less than the threshold or the number of iterations reach the given time. This algorithm can protect the laser foot points which are under terrain surface, and keep the ditch and depression.

3.4 Mosaiking of image

3.4.1 Label processing of non-ground point

Connected component labelling is a routine procedure in digital image processing. We can mark and get each differ region in image by inspect the connectivity among each pixel and its neighbor pixel. Because the sorts and quantity of ground object in urban area are plentiful，and the connected region is fracture and distribute wide，we use a sort of new region labeling algorithm based pixel.

3.4.2 Building segmentation

We segment building by computing the characteristic parameter of each connected region. The parameter including: texture mean, variance, perimeter, area, the most macro axis, azimuth, shape factor, moment about the mean etc. According the prior knowledge，we can using different parameter to estimate the property of each connected region.

Because the objects most are building, vegetation and vehicle in the non-ground points， and they have different spatial distribution: buildings are tightness and have more region； vegetation spread at definite scope， and it is not close connected among points；Vehicles have small volume and area. Because the pixel number of a region is proportional to the area of the region, we can judge the property of a connected region by accounting the number of the pixel in it. If the pixel number of a region is greater than a threshold，we assert the connected region is a building，else it belongs to other ground object. To ensure the classified quality，we need some prior knowledge of the region, and do some test, so that we can get the best threshold.

3.4.3 Morphological optimize

If some vegetation is connect a building（such as row tree）, we cannot distinguish them by connected component labeling and statistical method. We select appropriate window and structure operator and use mathematical morphology method to removal the "burr" around buildings. By this way, we can removal the vegetation connect buildings, and get define building data.

4. EXPERIMENT AND RESULT ANALYZING

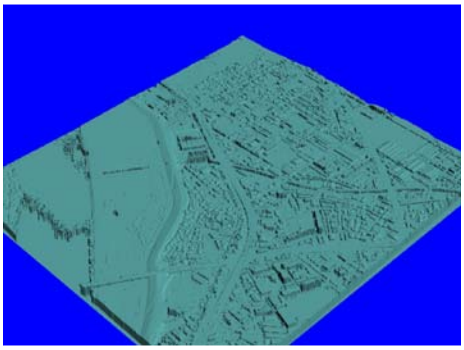
4.1 Test data

The test data is collected by ALTM 2050 made by Optech corporation. The test area is about 1.48km ×1.32km in Japan Osaka. There are prolific surface feature and object in the test area, such as dense building, stream and sloping field, scarp et al.

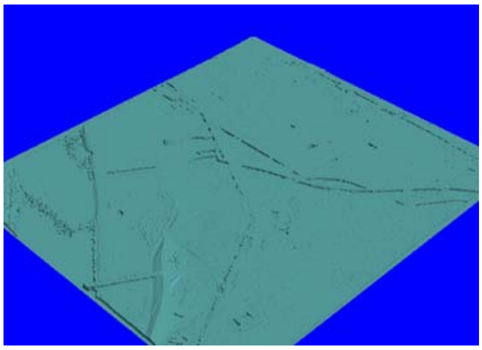
4.2 Experiment and result analyzing

Figure 2 is the experimental result of filtering, （a）is the original image;（b）is the result disposed by sub area surface (350m×350m) fitting method. From the result we can see, these test can removal object points information, at the same time reserve the initial form characteristic, such as ditch, dike in（b）.

Figure 3 is the experimental result of the segment building (part). We can see that the building segment is complete from (a) to (b).

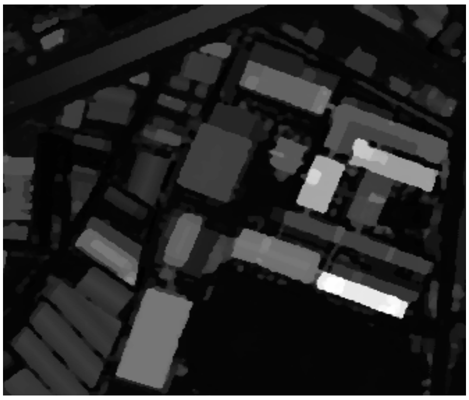


(a) original image

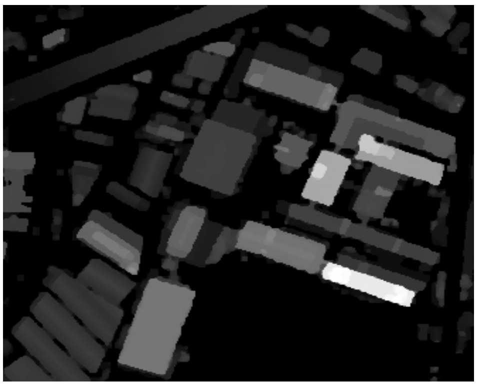


(b) result

Figure 2. Experimental result of filtering



（a）non-ground points data



（b） result

Figure 3.experimental result of building segment

5. EPILOGUES

In space informatics, the research of the terrain surface morphology is one of the most foundational and important things. How to obtain high accuracy DEM is the key. How to get the building information quickly is the key to the digital city. It is the difficulty and hotspot that to filtering the data to get DEM and to segment building information in LIDAR data processing. The theory and flow of the filter processing algorithm is developing with that of the hardware level of LIDAR technique, such as the increase in resolution wave band numbers increase.

This paper presents a sort of new fuse LIDAR data filtering algorithm and segment building flow which are both use the intensity information and range information of LIDAR data. An experimental data is disposed by using the flow and algorithm，and the result proves it is feasible.

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