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Project in Scientific Computing 2019

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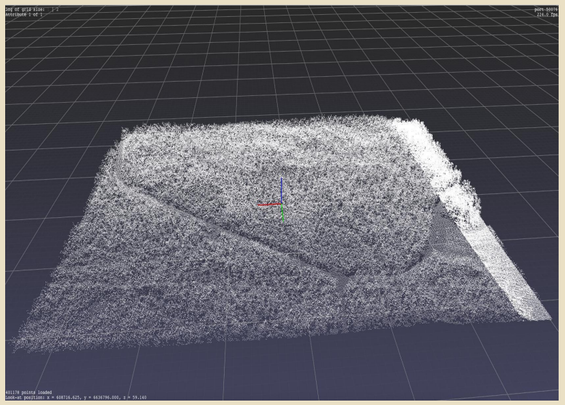
Road detection and characterization from LIDAR data

Summary

We developed a model based on python that takes point cloud data as input and through semantic sengmentation method to detect and characterization roads from the input data. The results are visualized on the map and the data of roads will be stored in a new file for further analysis and application.

Introduction

The National Road Database (nvdb.se) contains information about the whole Swedish road network, but mainly fouces on the public roads, private roads are often monitored infrequently, there is a lack of precision and even existence of information for major parts of the private road network.Based on the LIDAR point cloud data , we implement PointNet algorithm to identify roads and compute accurate measures of road



visualization of the given point cloud(Fig.1)

Statement of data

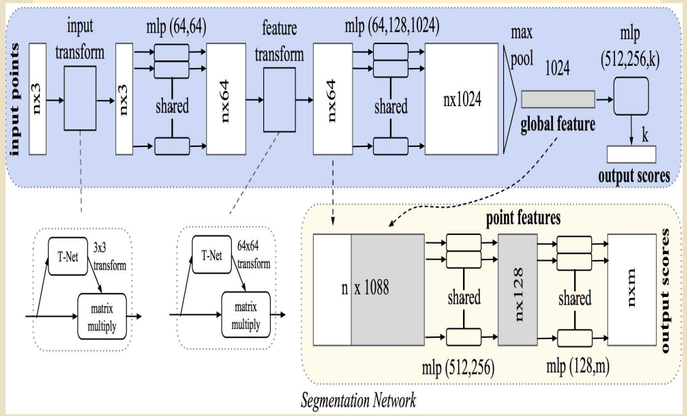
Fig.1 visualize the initial point cloud data, all scanned points in a certain area. These contain the X,Y,and Z geometric coordinates of a single point on an underlying surface, generated using 3D laser scanners and LiDAR(light detection and ranging) technology and techniques located on an aircraft through this area.

The main task is to identify closest points on road from a GPS coordinate(x,y,z) then compute road gradient, identify road from scratch. we trained a sengmentation model to generate the certain pattern of a road and using the trained model to automatically detect all roads from the inital points in certain area.

Method and Algorithm

PointNet is a point cloud processing network proposed at Standford University researchers.[1]

PointNet`s structure(Fig.2) is simple, it can directly output point cloud data, and then get the result of classification/segmentation. The model process independently on each point of the unordered point cloud.
The key structure in the network is a single symmetric function max pooling.
PonitNet takes advantage of the symmetric function, the largest pooling method, to fuse information from points in the point cloud. Its concrete structure is shown in the Fig2, where the input is point cloud data of 3 channels (x,y,z)(x,y,z)(x,y,z), and the output is a classification label or a segmentation result.



Structure of pointnet network(Fig.2)

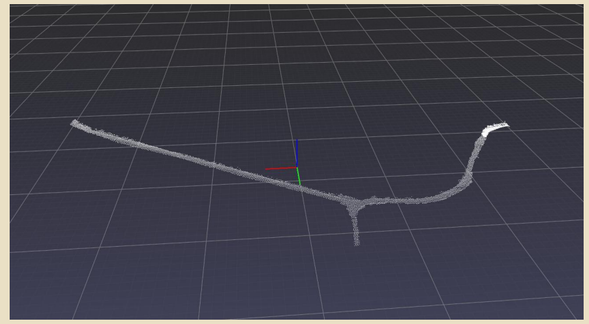
Training

We transfered the raw data which was given in the format of .las and csv file to hdf5 format as the pointnet netwark demands.

We set the total train epochs number as 10 and after 10th epoch a trained model will be generated in log file for further testing.
More detailed parameter in each train epoch such as current extracted batch form raw data and current mean loss and training accuracy will be showed after each epoch. And the evaluated mean loss and accuracy will be printed.
Some OBJ files will be created for prediciton visualization in the train log file at the same time when the trained model generated.

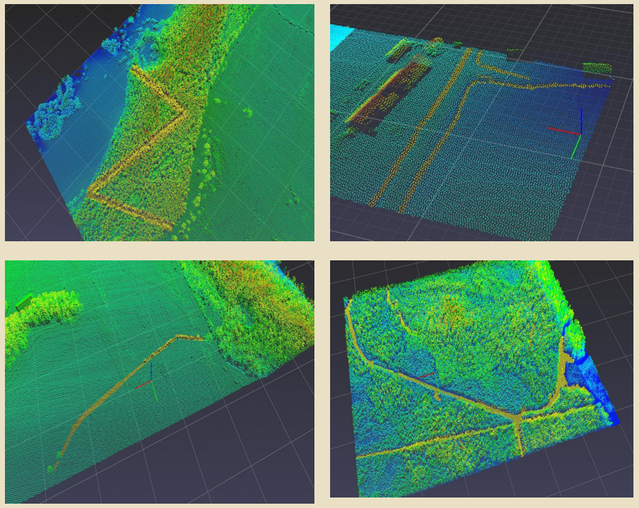
Testing and results

We present the results applied to a new area scanning point cloud in Fig.3 with a short discussion. As the scanning area of the raw data is really limitted so we are not sure the final results could present all the roads in certain area regardless of the size or the dimension of some roads.



One predicted roads(Fig.3)

Clear roads points are presented in the predict results. All the yeallow points are detected by our model as road.
More results are showed in Fig.4



More results, roads marked in yeallow.(Fig.4)

Conclusion and outlook

Fig.4 shows all roads in raw point cloud detected and characterize with some tiny noisy points(e.g in Fig.4 Pic 4 there is a straight line on bottom which acturally is not a road), we assume that those noise happen because the train data isn`t big and insufficient quantity

References:
1. Qi, Charles R and Su, Hao and Mo, Kaichun and Guibas, Leonidas. PointNet: Deep Learning on Point Sets for 3D Classification and Segmentation. Conference on Computer Vision and Pattern Recognition (CVPR) 2017