Geographic Visualization for Precision Agriculture

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Abstract

In this project, we worked on the visualization of soil data on 3D ground surface reconstructed from LiDAR cloud points. The soil and LiDAR data is free to download on-line. The LiDAR cloud points is in the format of *xyzi* and is of very large size and we generated the ground surface through down sampling and surface reconstruction. The original soil data is rendered on a planar map and the data is in the format of *shapefile*. We programmed in Python and rendered in matplotlib. The visualization of soil data on 3D ground surface can give a good picture of the different soil quality in different geographic regions. It is easy to support rendering based on soil property query through pandas. The project can be improved through shading and interactive GUI, which may be the future work.

1 INTRODUCTION

Precision agriculture (PA) is a novel farming management concept which can help analysts with smarter decisions through real-time data on weather, soil, air quality and so on compared to traditional agriculture. A good visualization of soil information on real-time 3D ground surface will be very impressive and helpful, which can show the relationship between soil quality and geographic data more clearly. The Iowa LiDAR project of the GeoTREE Center at the University of Northern Iowa provides several web-based services and a series of tools to help analyze and visualize the 3D ground surface in Iowa. The Web Soil Survey (WSS) operated by the USDA Natural Resources Conservation Service (NRCS) provides access to the soil information of the majority of the United States.

Both the LiDAR and soil data is free to download from the corresponding official websites. In this project, we worked on the visualization of soil data on 3D ground surface of Iowa.

2 DATA PROCESSING

2.1 LiDAR Data

The LiDAR data can be downloaded from the official website of the Iowa LiDAR project (http://geotree2.geog.uni.edu/IowaLidar/XXX.xyzi.7z , XXX is the tile id). In this project, the tile id 05044572, 05044574, 05064572 and 05064574 were used. The data format is *xyzi*.

The Iowa LiDAR project uses the coordinate of North American Datum of 1983 and we used a python library (pyproj) to convert it to the usual longitude and latitude of earth. The raw data is quite large and is not suitable for direct rendering. So it needs to be down sampled at first. The data is cloud points with no order so we cannot simply extract data at some interval. We divided the space into cells and looped the data to make sure each cell consisted of only one point. A reasonable division is 50 in each direction.

The next step is the surface reconstruction. There are many algorithms (e.g. ball pivot) and software for this job. Here we simply generated a 2D mesh in xy plane and interpolated the mesh vertices based on the cloud points. It is straight forward and quick while it may not be quite precise. The reconstructed ground surface is shown in Figure 1.

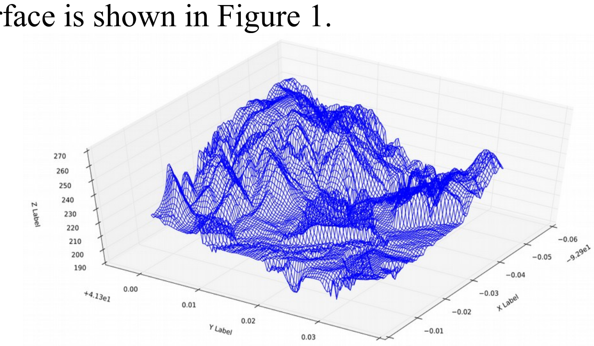

Figure 1 3D surface reconstructed from cloud points of the Iowa LiDAR data

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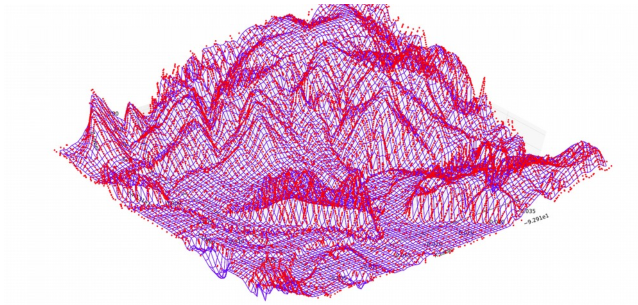

Figure 2 Reconstructed 3D surface and the down-sampled raw cloud points (red points)

2.2 Soild Data

WSS provides an interactive web interface to explore the soil data on a planar map. Here, we used Marion County in Iowa as the region of interest (No. IA125), see Figure 3.

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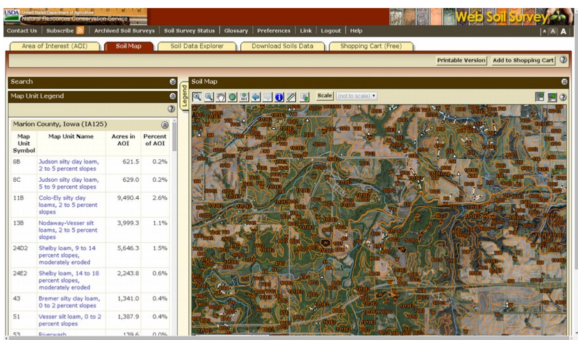

re 3 Web interface of WSS

The soil data downloaded from WSS is in the format of ERSI shapefiles. There are six files for a region of interest (ROA) and each consists of different information.

aoi_a_aoi	Polygon	Boundary of AOI
Soilmu_a_aoi	Polygon	Soil mapping unit boundaries
soilmu_l_aoi	Line	Line feature of soil mapping units
[a]soilmu_p_aoi	Point	Location of core collection for characterization
[a]soilsf_l_aoi	Line	Special feature noted during survey
[a]soilsf_p_aoi	Point	Special feature noted during survey

[a] Data set may not be populated depending on AOI.

Figure 4 Spatial files from WSS

Here, as the first step, we only used the second file, which consists of the boundary points of each polygon in ROA (red segments in Figure 3).

We programmed in Python and rendered using matplotlib, which is a convenient and interactive high-level graphic tool. The soil data processed and rendered in Python is shown in Figure 5.

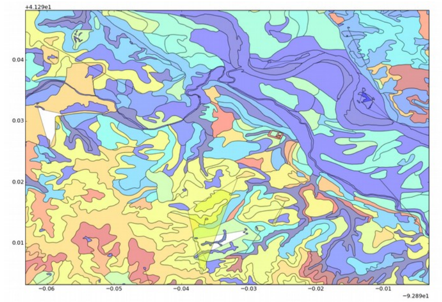

Figure 5 Soil information processed and rendered in Python

In Figure 5, there are more than 300 soil units and they are colored in a rainbow colorbar. The color indicates the unit type and it is very clear to see the distribution of the soil units in the above figure.

3. Combination of LiDAR Data and Soil Data

The next step is the visualization of soil data on 3D surface of LiDAR data. Matplotlib provides a convenient way to draw 3D polygons based on the 3D coordinates of the vertices. Here, we generated a 2D mesh and interpolated the z coordinates of the vertices on the surface using a nearest-neighbor method. The result is shown in Figure 6.

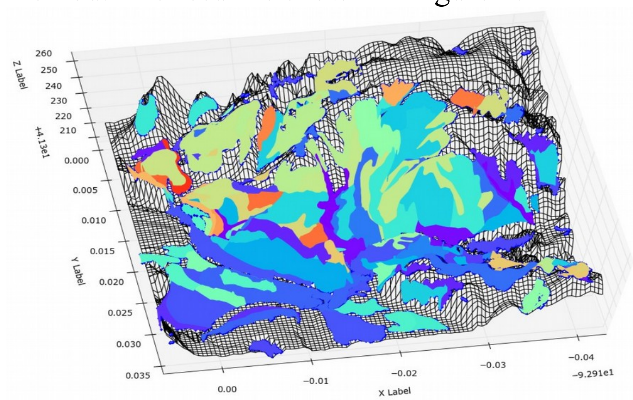

Figure 6 Visualization of soil data on 3D surface

It is easy to show different regions based on the queried soil properties. We can show one soil property on one picture each time at present. To show the high dimensional soil properties simultaneously requires further work in the future.

ACKNOWLEDGEMENTS

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