VIRTUAL REALITY (VR) VISUALIZATION OF GEDI L2A PRODUCTS

STARTER PROJECT VR (GEDI L2A), SPRING 2024, BROWN UNIVERSITY, RI

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March 13, 2024

ABSTRACT

This is the starter project for Brown Visual Computing Group with advice from David Laidlaw. This project aims to create the virtual reality (VR) visualization of the rh_0 and rh_98 measures from GEDI L2A products. And the general steps for this project are acquiring and processing GEDI L2A products, designing and implementing the visualization with the virtual reality (VR), and finally testing the implementation with the provided VR hardware.

Keywords Virtual Reality · Data Visualization · Data Science · More

1 Introduction:

The GEDI dataset stands for the Global Ecosystem Dynamics Investigation. It is a dataset produced by the NASA Global Ecosystem Dynamics Investigation Lidar (GEDI Lidar) onboard the International Space Station (ISS). The GEDI mission aims to provide precise 3D measurements of the Earth's forests and ecosystems.GEDI uses lidar technology to generate detailed observations of the vertical structure of forests, capturing information about canopy height, vertical canopy profiles, and forest structure. These data are valuable for studying biodiversity, carbon cycle processes, ecosystem dynamics, and the impacts of deforestation and forest degradation on a global scale.The dataset produced by GEDI consists of measurements and observations of forests and vegetation, providing scientists and researchers with valuable information to better understand and monitor changes in forests and ecosystems across the planet. These data are publicly available and support various environmental studies, climate research, and conservation efforts.

2 Data Source:

From the NASA website ,my aim is to collect the three-month duration what will be enough to cover RI. I used the filter in NASA website to select the desired three months dataset which passed the chosen circle containing Rhode Island. I derived 14 datasets, and I used all of them in my filter python code to obtain the desired json datasets.

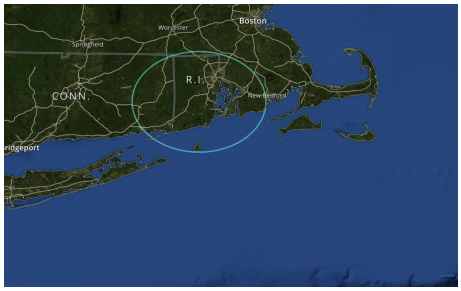

Figure 1: Filtering the desired h5 files covered Rhode Island in Three Months

3 Data Preprocessing:

In this project, I use the GEDI L2A dataset, which is a h5 file (Hierarchical Data Format 5 File). Following the tutorial in the website: GEDI_L2A_Tutorial, I simplified the code and derived geojson file regarding to the Rhode Island in Rhode_Island_Geojson.

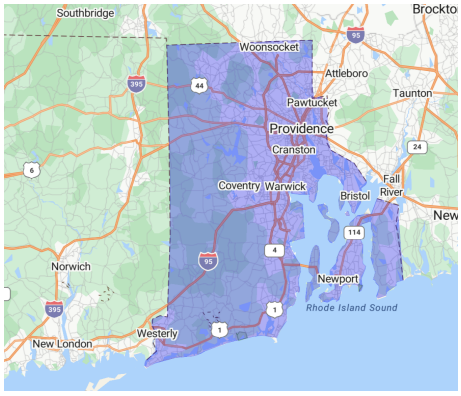

Figure 2: The Geojson in 2D covering Rhode Island

Also, I used the geopandas.tools.sjoin to directly intersect Points with the RI shapefile.

```
rhodegeometry.set_geometry('geometry')
allDF.set_geometry('geometry')
result=gpd.sjoin(left_df=allDF,right_df=rhodegeometry, how='inner',op='within')
```

Then, we implemented some conditions to select the satisfied beams and plotted the beam in Rhode Island. For example, in the Figure :

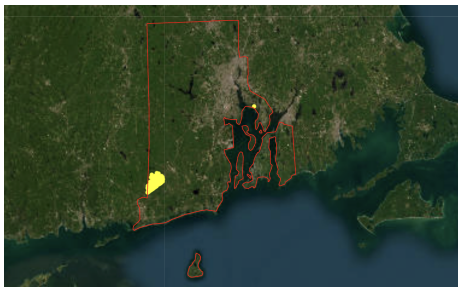

Figure 3: Example of one test in representing the beam covered in Rhode Island

4 Method 1: Unity Construction:

My idea is firstly to create a 3D earth. From the idea in Unity workshop , I slightly changed some codes to make the earth more beautiful shown in the following Figure:

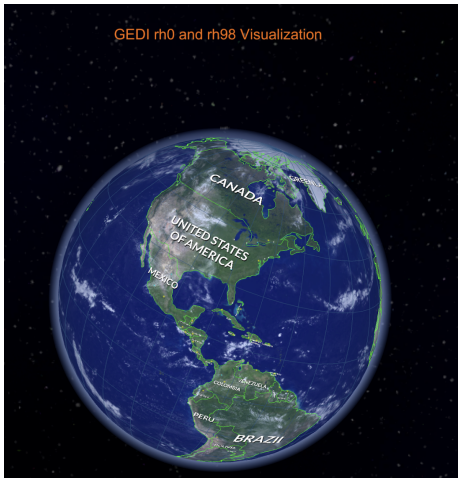

Figure 4: Unity 3D visualization of Global Map

Secondly, I need to make a 3D plat visualization of Rhode Island with L2A Rh0 and Rh98 with the help package cesium. Then, I can successfully generate the terrain with real height in the Rhode Island. The result is shown in the following figure:

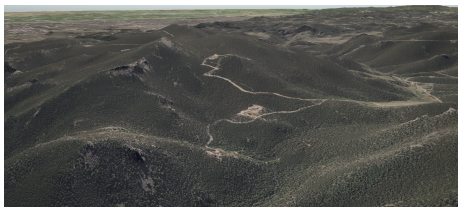

Figure 5: Real World Terrain of Rhode Island

Finally, I need to connect the 3D plat visualization of Rhode Island with the Earth to generate the final result, but I encountered the difficulties in connecting the Figure 5 into Figure 4. Also, I can only generated the small portion of the rh_0 and rh_98 successfully. But, it missed in visualization of a lot of data in geojson document.

5 Method 2: QGIS Construction

After filtering all the h5 documents, I combine all the json files into one json. And we can notice the 2D visualization of the distribution of the GEDI L2A dataset in the map as shown in the Figure:

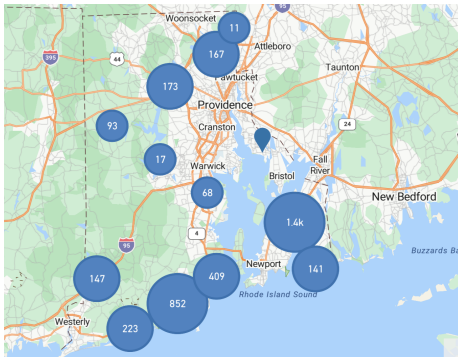

Figure 6: 2D distribution of the GEDI L2A Dataset

Also, I used QGIS to visualize the final Geojson file as the following:

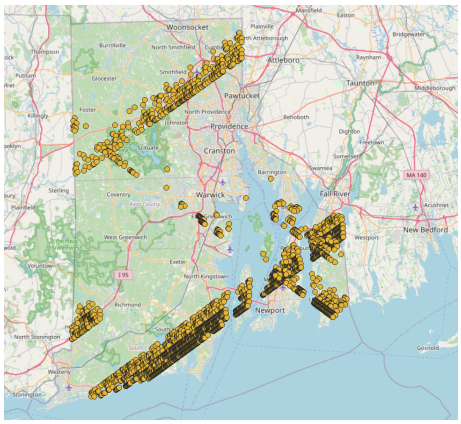

Figure 7: 2D distribution of the GEDI L2A Dataset in QGIS

And my idea in this method is to use the Figure 7 with a relative high dpi image in Unity. Then, I can use Unity to cover a sphere with this image shown as the following:

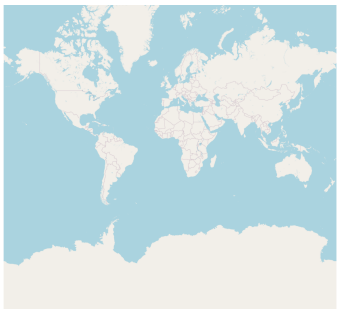

Figure 8: Image generated from QGIS in 2000 dpi

The Rhode Island is relatively small in the world map. And dpi is still relatively small if we want to generate a clear 3D visualization. The result of 3D in this method is shown in the following:

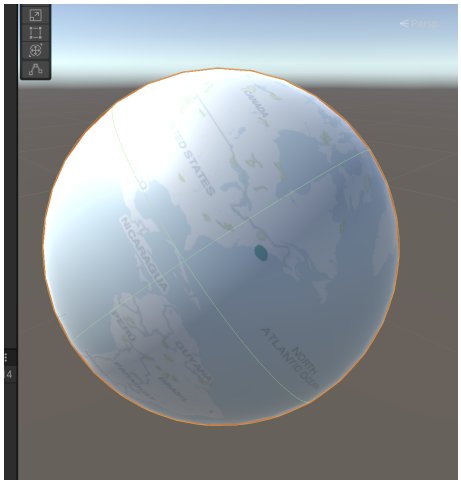

Figure 9: Connecting the Image with Sphere in Unity

And the result is bad in visualization of rh_0 and rh_98 because of the low dpi.

6 Method 3: Python Construction

Method 3 is to use Python to make a global map based on final collecting geojson data. Then, I can use a sphere in Unity to connect the image directly. But the image dpi is also a problem in this case.

Figure 10: GEDI L2A dataset distribution visualization using Python

However, when it comes to the world map, the distribution can not be shown clearly if we zoom in.

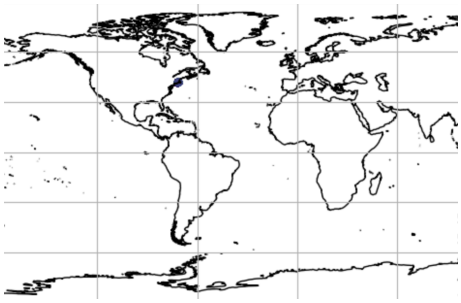

Figure 11: GEDI L2A dataset distribution visualization in global map using Python

We can see that the visualization is constrained because of dpi of image. So, the visualization is expected the same as Method 2.

7 Method 4: Geojson.io Construction

Method 4 is to use reference in visualization tool in Geojson file. And it is open source, my idea is to use the code of Geojson.io. The visualization is as following:

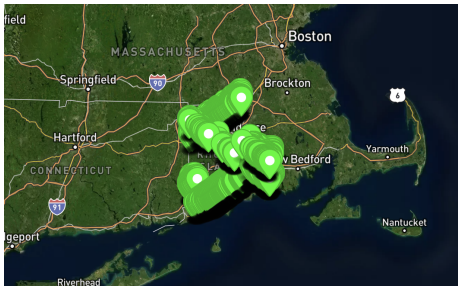

Figure 12: Use Geojson.io to generate visualization in 2D

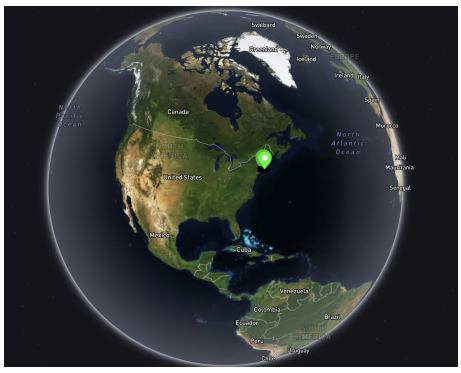

Figure 13: Use Geojson.io to generate visualization in 3D

8 Future Work

The visualization of method 1 is my own work. But I expect a clear visualization with real world terrain in real world height. I still need time in learning Unity to generate the best visualization especially how to visualize 3000+ effective data. I can visualize only a small portion of them. Method 2 and Method 3 are constrained in dpi of the image. So, I am

not prefer to use these two methods. And method 4 is highly based on work from others. And the real terrain in method 4 is still missing when we zoom in.