Elevation map to 3D sample object

Project : 3D printed landscapes

May 4, 2020

Bordeaux Université
Master Informatique 2019

Team members:

Tran Quang Tung
quangtung0276@yahoo.com
Nguyen Quoc Khanh
qkhanh2006@gmail.com
Nguyen Vu Anh Trung
kivanolai@gmail.com

Context

Nowadays, it is easy to obtain topographical data from satellites. These data, called elevation maps, consist in elevation levels across a grid. To be more simple, it is a 2D image where pixel values correspond to elevation levels.
One can find a lot of web databases corresponding to earth data but also elevation maps from the moon or mars for example.

Objective

The goal of this project is to implement a software taking an elevation map as input data and creating a 3D model that can be 3D printed (as shown in the figure below).

Work

In order to implement such an application, the following steps have to be followed :

1. Identifying databases and file formats for elevation maps
2. Mesh construction for the 3D model and
visualization of this mesh
3. Adding a shell to make the model 3D printable
4. Export to OBJ file (for use in Unity3D for example) and STL file (for 3D printing).

Requirements analysis

The first phase of of this project in first week of May is defining the Inputs and Output.

Data types

Standard elevation products are available in the following resolutions and formats:

- ***1 arc second (30 m) DEM – GeoTIFF***
- ***1 meter DEM – GeoTIFF, IMG***
- ***1/3 arc-second (10 m) DEM - GeoTIFF***
- ***1/9 arc-second (3 m) DEM - IMG***
- ***2 arc-second (Alaska – 60 m) DEM - GeoTIFF***
- ***5 meter DEM (Alaska only) - Varies***
- ***Contours (1:24,000 scale) – Shapefile, FileGDB***

Elevation source data are available in the following formats:

- ***DEM Source (OPR) – Varies***
- ***Ifsar Digital Surface Model (DSM) – GeoTIFF***
- ***Ifsar Orthorectified Radar Image (ORI) – GeoTIFF***
- ***Lidar Point Cloud (LPC) – LAS, LAZ***
- ***GDAL https://gdal.org/drivers/raster/gtiff.html***

Geo Tiff facts:

Strengths

The GeoTIFF file format is in widespread use worldwide. NASA DAACs provide data in GeoTIFF format as do other NASA Earth science data providers. There is strong software support in the form of the open source libgeotiff library and Geospatial Data Abstraction Library (GDAL) package. Many commercial GIS and spatial data analysis software products support reading and writing GeoTIFF data.

The Earth science cloud computing community is developing a means of optimizing GeoTIFF files for use in cloud computing workflows. Cloud Optimized GeoTIFF (COG) files adhere to the GeoTIFF specification so all prior software and workflows can consume COG files.

Weaknesses

While the GeoTIFF format provides for a tremendous amount of interoperability as evidenced by its widespread use within NASA and elsewhere, there is room for further discussion about how to increase interoperability. Work on this topic continues in the NASA Dataset Interoperability Working Group (DIWG) as part of the larger Earth Science Data System Working Group effort within NASA ESDIS.

Limitations

GeoTIFF is not necessarily suitable for every data type. There are other scientific file formats that are well established within the NASA community, e.g., HDF5 and netCDF, that are approved for use in NASA Earth science data systems.

GeoTIFF is not suitable for storing complex multi-dimensional data structures nor for storing vector data with many attributes or topology information.

Data catalog / Geo data warehouses

1. ***USGS National Geologic***
   https://viewer.nationalmap.gov/basic/

2. ***Google Earth***
   https://developers.google.com/earth-engine/datasets/catalog/

3. ***Open Topography***
   https://portal.opentopography.org/dataCatalog?listAll=true

4. ***NASA Shuttle Radar Topography Mission***
   http://dwtkns.com/srtm/

5. ***European Environment Information and Observation Network (Eionet)***

https://www.eea.europa.eu/data-and-maps/data#c0=5&c11=&c5=all&b_start=0

Bibliographies

1.Data type

https://www.usgs.gov/faqs/what-types-elevation-datasets-are-available-what-formats-do-they-come-and-where-can-i-download?qt-news_science_products=0#qt-news_science_products

2.Wolfram example
https://www.wolfram.com/language/gallery/make-a-3d-image-from-an-elevation-map/

3.Quantitative Geology and Automating GIS processes courses at the University of Helsinki Henrikki Tenkanen, David Whipp

https://github.com/Python-for-geo-people/Course-information

4.Geo Python

https://automating-gis-processes.github.io/2016/Lesson1-Intro-Python-GIS.html
https://automating-gis-processes.github.io/2016/Lesson7-read-raster.html

5.Earth Labs

https://www.earthdatascience.org/courses/use-data-open-source-python/intro-raster-data-python/fundamentals-raster-data/intro-to-the-geotiff-file-format/

6.Dask Geotypes processing with rasterIO

https://examples.dask.org/applications/satellite-imagery-geotiff.html

7.RasterIO Docs

https://rasterio.readthedocs.io/en/latest/

8.AccuTrans 3D

http://www.micromouse.ca/