GeoMesh

An Honors by Contract Project for EECE 2160: Application Programming

By Daniel Lynch

Under the guidance of Dr. Michael Geiger

Program Concept

Write a program in C that can generate .STL files based on geographic data.

These files can then be used to 3D - print objects, create objects or scenes for virtual reality and CG applications.

Make use of publicly available geographic data.

.STL

.STL files, .obj files, and other "mesh" file formats represent 3D surfaces as meshes of 2D shapes (usually triangles). The 2D shapes (called "facets") have vertices and orientation (defined outward pointing normal vectors). The vertices and normal vectors have coordinates.

attempt61.stl - Notepad

File Edit Format View Help

```
solid ASCII
  facet normal 0.000000e+00 1.000000e+00 0.000000e+00
    outer loop
      vertex   1.000000e+01 3.000000e+01 0.000000e+00
      vertex   0.000000e+00 3.000000e+01 0.000000e+00
      vertex   0.000000e+00 3.000000e+01 1.000000e+00
    endloop
  endfacet
  facet normal 0.000000e+00 1.000000e+00 0.000000e+00
    outer loop
      vertex   1.000000e+01 3.000000e+01 0.000000e+00
      vertex   0.000000e+00 3.000000e+01 1.000000e+00
      vertex   1.000000e+01 3.000000e+01 2.000000e+00
    endloop
  endfacet
  facet normal 0.000000e+00 -1.000000e+00 0.000000e+00
    outer loop
      vertex   0.000000e+00 0.000000e+00 0.000000e+00
      vertex   1.000000e+01 0.000000e+00 0.000000e+00
      vertex   1.000000e+01 0.000000e+00 7.000000e+00
    endloop
  endfacet
  facet normal 0.000000e+00 -1.000000e+00 0.000000e+00
    outer loop
      vertex   0.000000e+00 0.000000e+00 0.000000e+00
      vertex   1.000000e+01 0.000000e+00 7.000000e+00
      vertex   0.000000e+00 0.000000e+00 6.000000e+00
    endloop
  endfacet
  facet normal 0.000000e+00 1.000000e+00 0.000000e+00
    outer loop
      vertex   2.000000e+01 3.000000e+01 0.000000e+00
      vertex   1.000000e+01 3.000000e+01 0.000000e+00
      vertex   1.000000e+01 3.000000e+01 2.000000e+00
    endloop
  endfacet
  facet normal 0.000000e+00 1.000000e+00 0.000000e+00
```

GEOGRAPHIC DATA

There is a ton of available geographic data on the internet including:

- Elevation Data
- Watershed Data
- Vegetation

Available Elevation Data

- USGS 3DEM Project (total coverage at about 3m resolution)
- USGS LiDAR Pointcloud Data (Spotty coverage but high resolution)
- Elevation API's ("Applictaion Programming Interface"): GoogleMaps, Bing, and more

3800   3600   3400   3200   3000   2800   2600   m

Game Plan

1. Research the .STL file format
2. Build a 2D array of elevation data
3. Generate a closed-solid .STL file based on the data
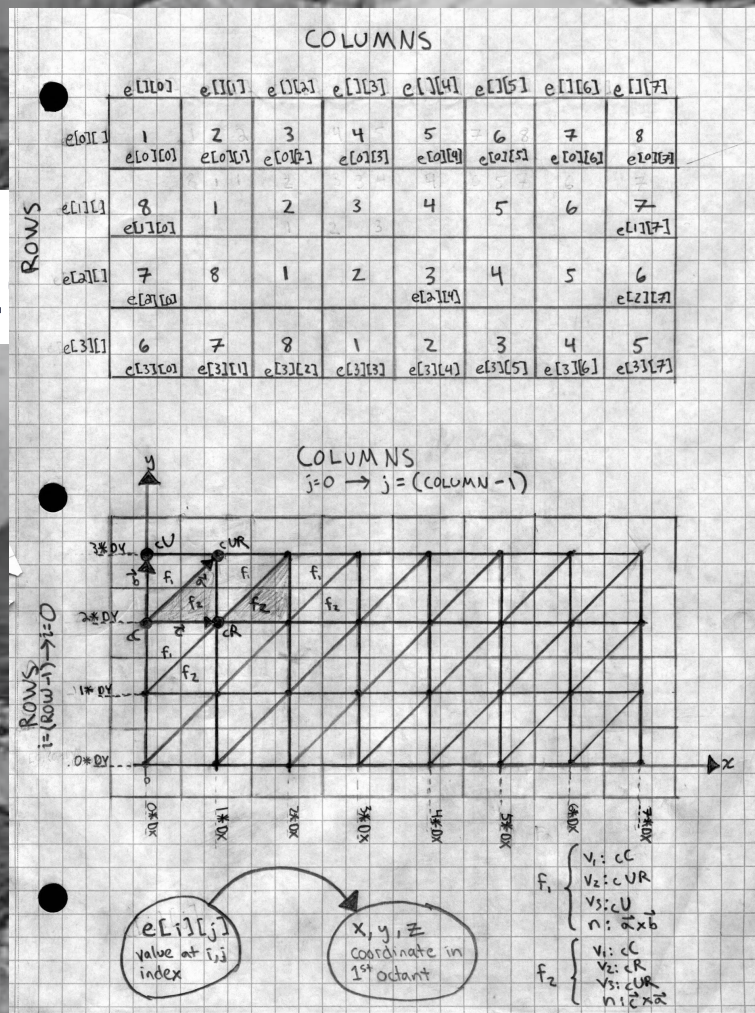4. Get elevation data from one of the resources and use it in my program
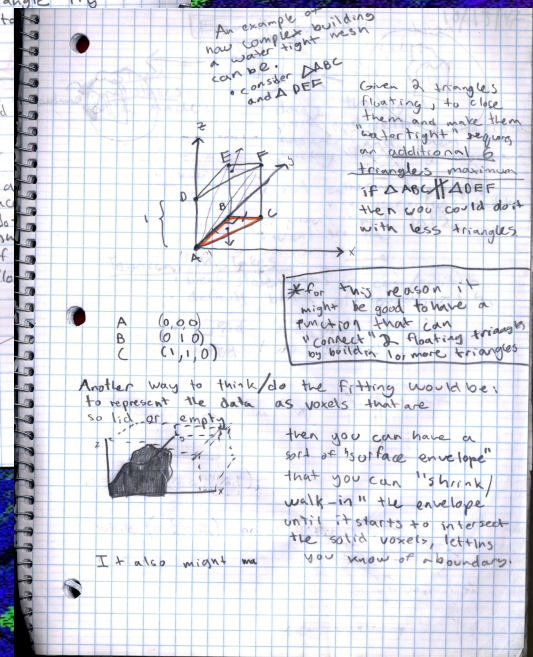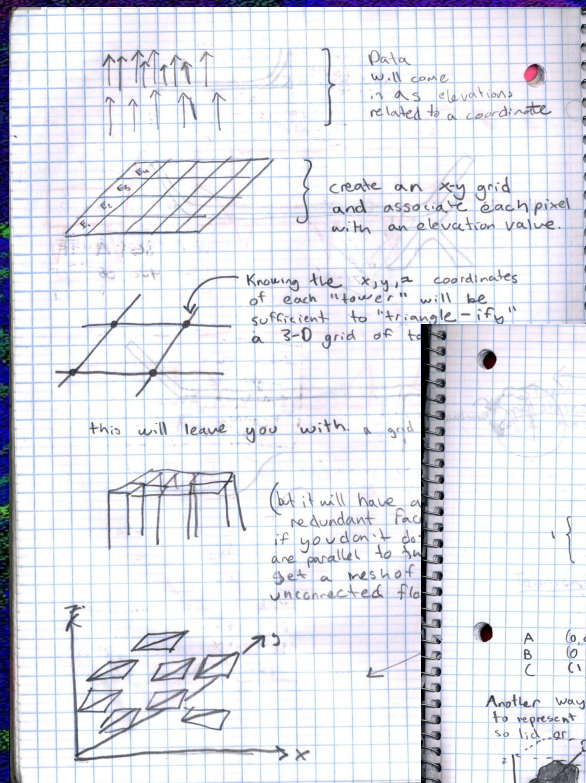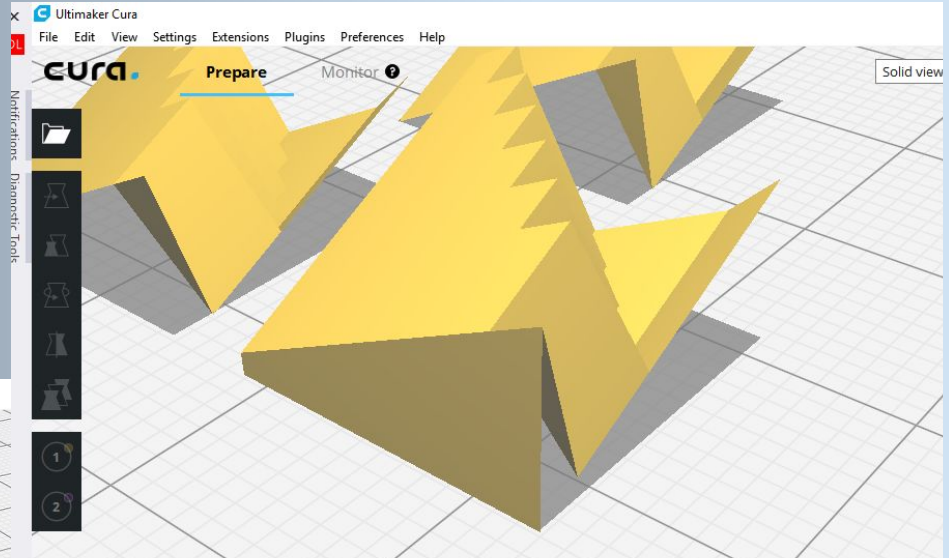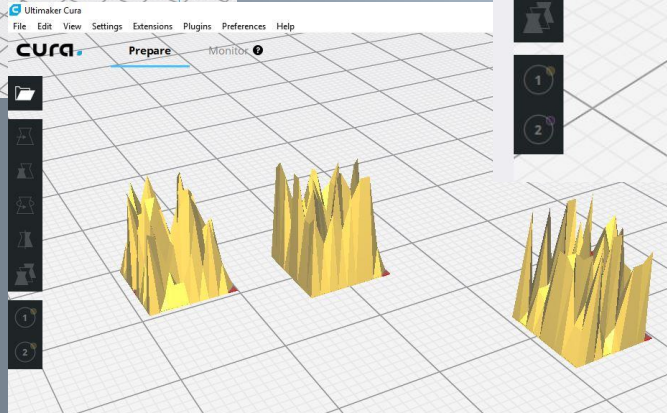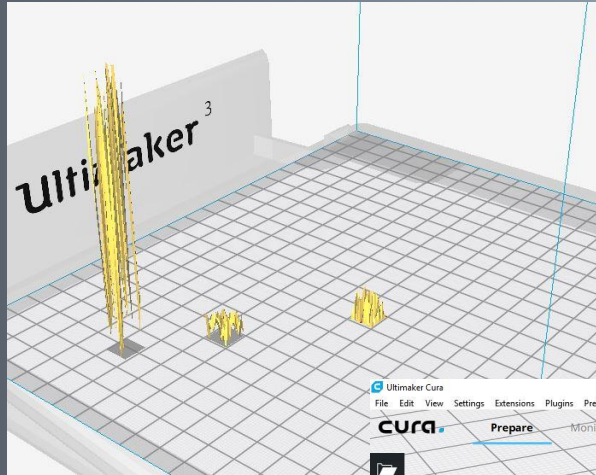
Generating STL Fil

From 2D Arrays

Coming up with a process for defining all of the facets of the surface.
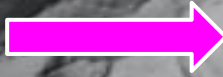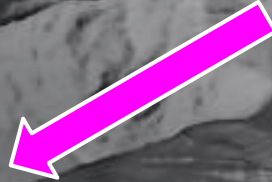
TRIAL AND ERROR

Road Blocks

Temporary Fixes

Underestimating the complexity of parsing the geographic data from USGS.
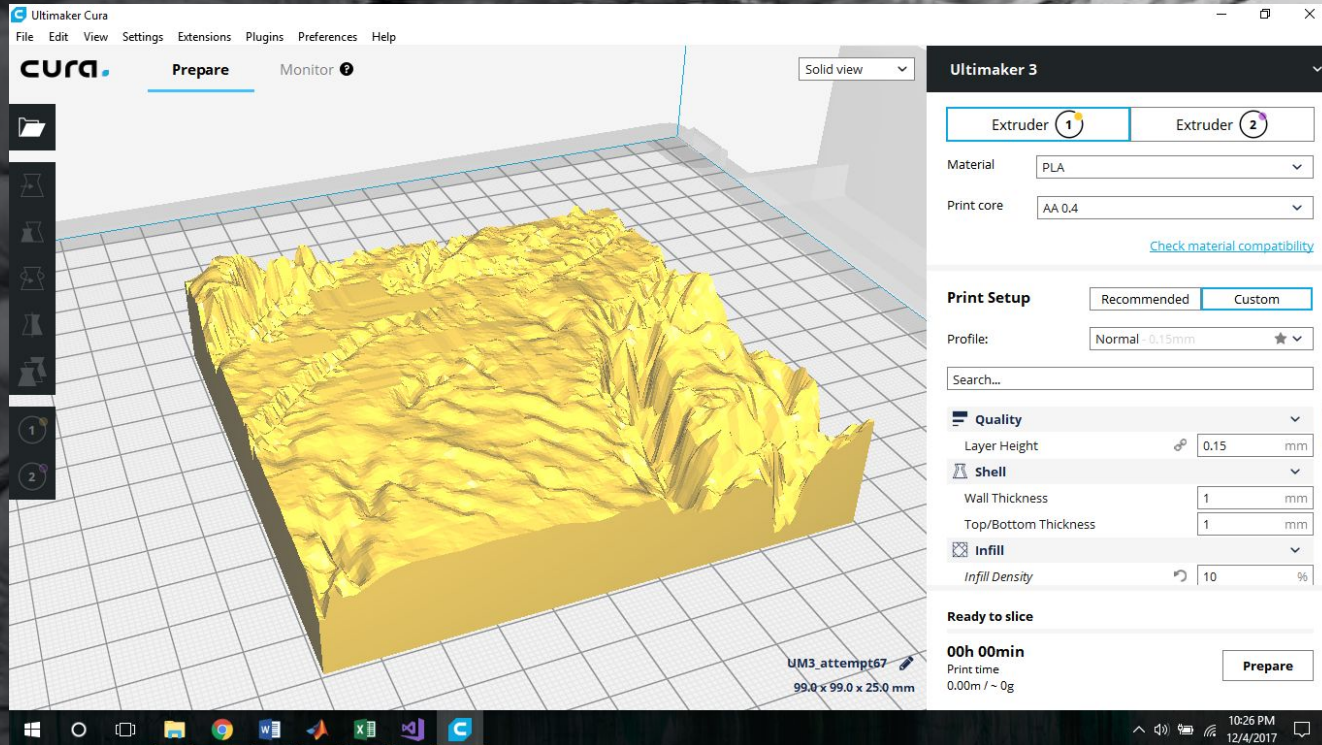
Use the API's!

C isn't the best language/way to access API's.

Using MATLAB to generate 2D "elevation" arrays from photograps.

Some Success

What I Used From Class

Here are some tools I used from class:
- C functions
- 2D arrays
- For loops
- Custom Data Structures

What I Learned/Practiced:

Here is some experience I got while doing this project:
- Building and Debugging in Visual Studio
- Project Structure
- Reading Technical Documents
- Learning how to break big projects into smaller pieces
- Testing code

Short Term:

- Getting the data from the API's

- Smoothing functions

- Writing the files in binary and not ASCII format

- Putting project on GitHub

Long Term:

- Getting the project online with JS and NODE.js

- Getting involved with other OpenXSource GIS and STL projects

What's next?

Thanks.

Thanks to Dr. Geiger for taking the time to work with me on the project. And thank you to the Honors College (Beth specifically) for letting me do this.

Resources Used

- Dr. Geiger's Lectures and Project Notes
- The USGS GIS tutorials
- Cura
- The 3D printing community
- 3D Systems
- MATLAB Documentation
- Programming in C by Stephen G. Kochan