Problem:

The overarching problem this project aims to solve is the reconstruction of the surface of a point cloud. Going into specifics, a point cloud is a collection of many points seemingly randomly scattered about the surface of an object(s). To make this data more useful and directly applicable to existing programs and software, this project will focus on reconstructing the surface of the point cloud. Additionally, this project aims to circumvent an issue with many popular implementations that don't allow for discontinuous voids or sections of parts to be calculated.

Plan:

The plan for the project is to use a level set method, among other algorithms, to reconstruct the surface of a point cloud. Using these methods, the program will produce a scalar field representing the surface of the object(s). Expanding this, that scalar field will then be plugged into the marching cubes algorithm—the project we created last year—to create a discrete mesh of polygons in the form of an STL file. STL files are highly useful as many applications accept them, including most commercial 3D printing software.

Progress:

A working prototype of the surface reconstruction has been created in python3 (this will later be ported to C++ to improve performance). Additionally, to smooth the data and improve accuracy, a surface tension simulation was created—some tweaks are being worked on for the simulation.

The prototype program uses the level set method to construct a rough outline of the object's contours and surface, which produces a scalar field. The scalar field is then run through a surface tension simulation to improve smoothness and accuracy. Finally, to produce the complete scalar field, an algorithm that utilizes a flood fill algorithm, among others, determines which sections of the part are solid or air to allow proper interpretation of the part after it's run through marching cubes.

The project can be found on GitHub:
https://github.com/AndrewDMorgan/Point-Cloud-Surface-Reconstruction

Expected Results:

The program and its pipeline should produce a discrete polygonal mesh that accurately and smoothly reconstructs the surface of the point cloud. This mesh should be precisely formed-fitted to the points to ensure proper tolerances on high-precision parts in applications such as machining.

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