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# Creating 3D Volume Data for a Polygonal 3D Object

## Abstract

Irregular grids have long been used in computer graphics as a visual representation of digital creations. While most common uses of this type of grid are limited to 2D, this project aims to demonstrate their use as a way to fill a 3D space. This system would create a standard grid within the defined space, manipulate and deform the interior of the grid, while ensuring the grid maintains the approximate shape and structure of the original 3D space. The resulting grid, while it would have the desired outside shape, the interior would consist of cells of varying size and shape. The goal of this project is to show that an irregular grid can be used to transition from a 3D polygonal object to create equivalent volume data description of the same polygonal object.

## System Description

This system would work by generating a standard grid, deforming the grid and rebalancing the grid so that the topology is still valid. The most basic version of this system works on a 2D grid by taking the generated standard grid, subdividing a percentage of the grid cells by placing a new node within the grid cell, removing edges from the grid nodes until a threshold is reached, and relaxing the entire grid.

The 3D version would function similarly, however the degree of difficulty is much higher than the 2D version as we would require creating a grid from a basic geometric polygonal shape. Five basic shapes would be used to test the underlying algorithm for any issues that might arise from adding an extra dimension to the grid, specifically how close the volume description is to the polygonal 3D object. From there, the basic 3D version would be expanded and made more flexible by changing how the initial, standard grid is generated. Instead of using a basic geometric shape, the grid would be generated from a series of anchor points that would serve as the outer extremes of the grid, this will allow the grid to follow and pass through each anchor point and is a significant extension of our idea. These anchor points would allow the generated grid to fill the space defined by them as well as allowing for a less rigidly defined grid shape.

## Timeline

System Design and Creation: February 2023 - March 2023	
February 1st	Create and Test 2D version
February 15th	Expand 2D version to 3D and Test
March 15th	Expand 3D version to fill a defined space and test
Finish Documentation and Thesis Requirements: April 2023 - May 2023	
April 1st	Set date for oral Defense
April 15th	Thesis Document Creation
May 1st	Defense and Thesis Corrections

## Keywords

Irregular Grid: Also known as an unstructured grid, an irregular grid is a grid where each grid cell has a different size and/or shape.

Standard Grid: A grid where each grid cell is congruent.

Node: Within the contexts of this project, a node would be defined as the vertices of the grid.

Relaxing the grid: Within the contexts of this project, relaxing, or rebalancing, the grid refers to manipulating the nodes of a grid in such a way that the nodes evenly fill the interior space of the grid.

Anchor Point: Within the contexts of this project, an anchor point would be a node that serves as a corner vertex that the rest of the grid would be built from.

## References

<https://imgur.com/gallery/i364LBr>

<https://arxiv.org/abs/2205.13914>

[https://patterns.eecs.berkeley.edu/?page\\_id=524](https://patterns.eecs.berkeley.edu/?page_id=524)

<https://youtu.be/1hqt8JkYRdl>