Triangle Filling,
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1. Introduction

Triangles are the most common shape and polygon in Computer Graphics, because of their structural fundamentals and properties. In this project we deal with Triangle Filling, determining the color that each triangle should be filled with in order to display an image, if given with the respective data concerning the details about the triangles.

This project is implemented in Python and extensively on the Numpy library. We implement 2 different triangle fill algorithms, **flat** and **gouraud**, demoed in the demoFlat.py and demoGouraud.py files respectively. Each file loads the ".npy" triangle data file about the image to be displayed and then depending on the algorithm used, a render function is called and run.

2. Data

The data given in order to display and save the image consists of:

- Verts2d: An L x 2 matrix with the coordinates of each vertex.
- vcolors: An L x 3 matrix with the RGB values of each vertex.
- faces: A K x 3 matrix with the indices of each triangle.
- Depth: An L x 1 matrix with the depth of each vertex.

3. Implementation

   a. Flat Rendering

Given the dimensions of M x N for the image we calculate the mean color value for each triangle in order to determine the end values for each triangle. In the meantime we calculate the respective (x,y) coordinates that are to be colored. This is achieved by examining Active Edges through vertical scanning, meaning that edges intersected by a horizontal line y, given that y is between y_{min} and y_{max} , the bottom and the top of the triangle in question respectively. Once this is completed on one triangle, the Active Elements are updated, searching for the next active Edge and Vertex.

   b. Gouraud Rendering

The procedure during the "smooth" Gouraud rendering is similar to that of the *flat coloring,* however in order to achieve the smoother colors, we need to calculate the color interpolation. Through this approach we presented by a more seamless transition of colors from polygon to polygon, it was noted however that this method required almost double the execution time, as compared to flat rendering.

4. Results

Image Produced with Flat Rendering.

Image Produced with Gouraud Rendering

As expected the color transition between triangles is far more noticeable with the flat shading technique and almost all of the triangles of the shape are clearly discernible. Gouraud Rendering on the other hand, presents an image in which there is a more gradual color transition and the triangles are notably less clear.