

ADVANCED ALGORITHMS AND PROGRAMMING METHODS CM 470-2

Assigment 1

Student:

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Problem

In this assignment I had to implement a software 3D rendering pipeline with programmable fragment shader. Assume the pipeline receives triangles already in view coordinates, project them, rasterize the triangle, interpolate the vertex attributes, and for each fragment pass the interpolated vertex to the fragment shader. Render to a software target, a continuous region of memory (e.g. array or vector) of a parametric type target_t which holds the rendered image in row-major format and can be used to display or save the rendered image. The pipeline must be agnostic with respect to type (target_t) and dimensions of the target. The fragment shader, when producing a fragment, must provide a target_t. Implement the shader in terms of a strategy pattern, i.e., a call to a polymorphic funcion in a class held by the pipeline, but hot-swappable. Assume a single known vertex definition with pre-specified attributes (3D coordinates, 3D normals and u,v coordinates) known by the polymorphic interface. We will relax these assumptions as well as move away from the polymorphic call in later iterations. Do not worry about textures at this stage. Turn in code and a report specifying usage of the pipeline and design decisions. A working test example is much appreciated.

Resolution

To solve this problem I decided of created a class called Point where are stored all parameters, specifically: 3D coordinates, 3D normal coordinates, 3D raster coordinates (over this I added coordinates x and y as integer to use to draw) and coordinates u, v. Moreover I implemented class Fragment_shader where I inserted a method called draw with which I can draw in the screen, for drawing need to create a sub class where it override the method draw. As last class I created Rasterization where during initialization it takes dimension of canvas and it inizializes the prospective matrix. As parameters in this class I decided to have: a matrix where is stored the prospective matrix, an array where is stored parameters a b c d for the equation plane, an z buffer vector for the depth, a pointer to the screen and a pointer to the sub class of Fragment_shader. After it needs to call set_shader_and_screen to take the shader and the screen that I want to use and also it takes screen's dimension. The most important part of this class is the method render_triangle which takes three points and create the triangle. To do this at the beginning of the algorithm I change the coordinates of the points to raster coordinates, after I have to sort the vertexes in clockwise order altrought the edge function doesn't work. To do this I find the minimum vertex on lower left and this will be the first vertex, after I use the inner product $\vec{a} \times \vec{b} = |\vec{a}| |\vec{b}| \cos \theta$ to find the corner among this point and other, the point with minimum corner will be the second vertex. Ordered the vertexes I find the plane equation, so in this way I can find the z raster coordinate knowing x and y raster coordinates. in the last step I decrease the dimension of positions that I have to watch and in these positions I watch if this point is inside the triangle or not. In this phase I use the shader that I override in main function so in this way I can print what I want in the screen. Clearly Fragment_shader and Rasterization have a parametric type target_t so in this way I can use whatever type of screen and whatever return type for draw function.

Example of running using the following points:

- screen is a 150x50 char buffer;
- the scene is composed of 2 triangles of vertices v1, v2, v3, and v1, v3, v4;
- v1=(1,-1,1.5)
- v2=(1, 1, 1.1)
- v3=(-1, 1, 1.5)
- v4=(-1, -1, 1.9)
- the projection matrix has left=top=-1, right=bottom=near=1, and far=2;
- the shader returns the first character of the decimal expansion of the z coordinate.

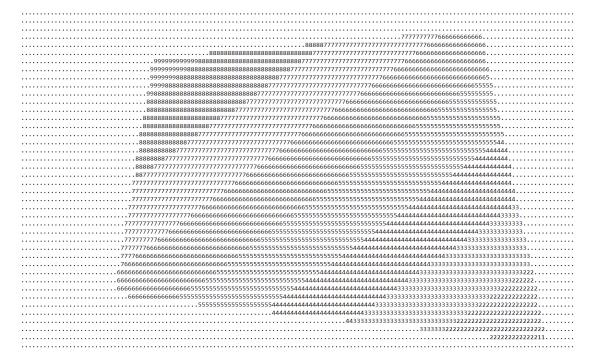


FIGURA 1: Example of running