Cel Shading using a Sobel Filter and Variable Quantization

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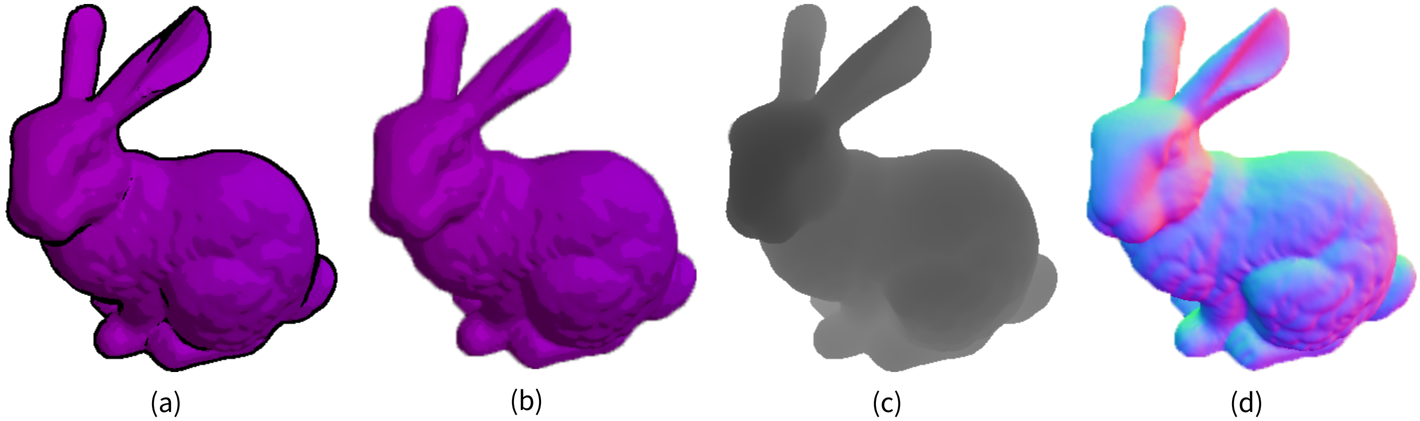

Figure 1: (a) Cel-shaded Stanford bunny, (b) color quantization, (c) depth information texture, (d) normal information texture

1 Introduction

Cel Shading is a type of non-photorealistic rendering widely used in computer graphics to make objects appear flat and hand-drawn by limiting colors and adding outlines.

The technique of limiting colors is called color quantization and involves converting the smooth lighting values into a small number of discrete shades, as soon in figure 1b.

The technique of drawing outlines can be done in various ways, but I chose to use the widely known Sobel operator. The Sobel operator is used in computer graphics with edge detection algorithms to highlight edges. I chose to use technique because it is relatively inexpensive in terms of computation and can be implemented in a fragment shader.

2 Approach

To implement color quantization, I created a 1D texture of 8 increasing floating point values. This made testing different values very easy and it made it possible to declare multiple quantization maps (qmaps in the code) that can be toggled between in the GUI. The texture is passed into the fragment shader where a lookup is performed using the same intensity we computed in assignment 2 for lambertian lighting. This texture lookup returns a floating point value that can be used to scale the fragment color. Because the quantization maps were declared in ascending order, the higher the intensity, the brighter the fragment will appear.

To implement the outline edge detection, I created a framebuffer object which mapped depth and normal information to 2D textures, shown in figures 1c and 1d, respectively. The 2D textures were passed into the fragment shader where a sobel filter was applied to both textures separately. I then averaged the r, g, b components of both textures and added them together to create an outline intensity value. Finally, I drew the fragments where the outline intensity value was high enough black to create the outline effect shown in figure 1a.

3 References

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