Homework 3

Due Sept 23, 2009 by email to Peter.

1. Modify \texttt{gasket3.c} as follows. (30)
   a. Instead of subdividing a tetrahedron into 4 smaller tetrahedra, subdivide a cube into 27 smaller potential cubes with 14 of them further subdivided and the others empty.

   ![Diagram of subdivided cube]

   b. Change the orientation every time the scene is redisplayed.

   ![Diagram of oriented cubes]

   Hand in the source code and a sample screendump.
There was a requirement of coding for 27 cubes and possibly using a wireframe for the other 14 cubes, though it was also acceptable not to display the 14 other cubes.

2. Write a program that prints the new width, height, and area of your OpenGL window whenever it is resized. \(\text{(10)}\)

Look through code, shouldn’t be too hard.

3. (The point of this question is to introduce you to one of RPI's graphics alumni. Find the answers with your favorite search engine.) \(\text{(15)}\)
   a. Name and describe in your own words the most recent project of Dr. Chandra Narayanaswami, PhD (RPI), and Manager, Wearable Computing, IBM TJ Watson Research Center?

   SoulPad. Allows user to save desktop session from one computer and boot it on another.

   b. Describe one of his patents.

   SoulPad, Linux Wristwatch, Personal Mobile Hub

   c. Who was his PhD advisor at RPI?

   Prof. Franklin

4. Do Angel, page 37, exercise 1.8, but use 65 frames per second instead of 72. \(\text{(15)}\)

\[1280 \times 1024 \text{(pix/frame)} \times 65 \text{(frames/sec)} = 85196800 \text{ pixels/sec i.e. 11.7 ns/pixel}\]

Interlaced video => Using half the required bandwidth

Total pixel rate = \(640 \times 480 \times 0.5 \text{ (pixels/frame)} \times 60 \text{ (frames/sec)} = 9216000 \text{ pixels/sec i.e. 108.5ns/pixel}\)

the wikipedia has comparisons as well but some values tend to be beyond the
card specification(beware!)

1. How rapidly has the geometric performance improved?

<table>
<thead>
<tr>
<th>Graphics Card</th>
<th>Release Year</th>
<th>Core Clock</th>
<th>Memory Bandwidth</th>
<th>FLOPS</th>
<th>Pixel Fill rate</th>
<th>Texel</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3dfx - Voodoo2</td>
<td>1998</td>
<td>90Mhz</td>
<td>2.13Gb/sec</td>
<td>N/A</td>
<td>90 Mpix/sec</td>
<td>180MTexel/sec</td>
<td>Used for Doom 3D (one of the most successful, revolutionary games), Duke Nukem (historic games)</td>
</tr>
<tr>
<td>GTX 295</td>
<td>2009</td>
<td>576 Mhz</td>
<td>223.776Gb/sec</td>
<td>1788.48 GFlops</td>
<td>32256 Mpixel/sec</td>
<td>92160MTexel/sec</td>
<td>Half-Life, Gears of War (computationally intensive)</td>
</tr>
<tr>
<td>ATI Radeon 5870</td>
<td>2009</td>
<td>725 Mhz</td>
<td>128Gb/sec</td>
<td>N/A</td>
<td>23200 Mpixels/sec</td>
<td>52200 MTexel/sec</td>
<td>Uses GDDR5 Memory, 1044G Shader Operations/sec (fast)</td>
</tr>
<tr>
<td>Larrabee (Intel)</td>
<td>Unreleased</td>
<td>32 Cores at 1GHz</td>
<td>N/A</td>
<td>2TFLOPS</td>
<td>N/A</td>
<td>N/A</td>
<td>Wait and watch</td>
</tr>
</tbody>
</table>

The graphics processing has grown manifold, each manufacturer has
concentrated on a few areas increasing the overall performance e.g. ATI
has a varied pixel to texture fill rate pipeline and introduced shader
processing. Nvidia has increased the core processing, high frame
buffering, proprietary pipelining architecture. (The idea is to understand
the various parameters for GPUs).

a. Pixel processing capability?
Any of the above mentioned would also directly or indirectly contribute to the pixel processing capability.

b. Cost/rendered triangle?
Is a more traditional method and used primarily for old graphic cards. Currently it is more based on the ability to do ray tracing (real time e.g. the new ATI Radeon, Larrabee would like to achieve), shader operations, Texels, memory bandwidth would be preferable methods. (Any comparison including any of the above will be considered). Nevertheless the idea is that it has reduced by a significant quantity i.e. around 40-50 times over the last decade.

6. Do Angel, page 97, exercise 2.19. (15)

Pick two arbitrary points inside shape or on boundary

Check if line connecting them crosses boundary

If it does, not convex

Else, is convex

7. Do Angel, page 98, exercise 2.22. (15)

\[ V = \frac{1}{3} \times \frac{\sqrt{3}}{4} \times a^2 \times h = \frac{\sqrt{2}}{12} \times a^3 \]

\[ V_{sub} = \frac{\sqrt{2}}{12} \times \left( \frac{1}{2} a \right)^3 = \frac{1}{8} \times \frac{\sqrt{2}}{12} \times a^3 = \frac{1}{8} \times V \]

\[ V_{sub, tot} = 4 \times V_{sub} = 4 \times \frac{1}{8} \times V = \frac{1}{2} \times V \]

\[ x = \text{surface area of 1 side of full tetrahedron} \]

Full surface area = 4 * x
Surface area of each subdivided side = \( \frac{1}{4} \times x \)
Total area = \( \frac{1}{4} \times x \times 4 \text{ sides/sub} \times 4 \text{ tetrahedrons} = 4 \times x \)

Full tetrahedron surface area : total of subdivided surface area = 4:*x:4:*x = 1:1