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CSCI 4229

1) The frame rate reported by the program when the window is different sizes, specifically 1x1, 300x300 and full screen. Explain your results.
(Changing the sized in line397)

Size 1x1:
```
12158 frames in  5.000 seconds = 2431.600 FPS
21752 frames in  5.000 seconds = 4350.400 FPS
18568 frames in  5.000 seconds = 3713.600 FPS
19689 frames in  5.000 seconds = 3937.800 FPS
20419 frames in  5.000 seconds = 4083.800 FPS
21759 frames in  5.000 seconds = 4351.800 FPS
21009 frames in  5.000 seconds = 4201.800 FPS
```

Size 300x300:
```
300 frames in  5.000 seconds = 60.000 FPS
300 frames in  5.001 seconds = 59.988 FPS
300 frames in  5.000 seconds = 60.000 FPS
300 frames in  5.001 seconds = 59.988 FPS
300 frames in  5.001 seconds = 59.988 FPS
300 frames in  5.000 seconds = 60.000 FPS
300 frames in  5.000 seconds = 60.000 FPS
```

Size 2880x1800:
```
10884 frames in  5.000 seconds = 2176.800 FPS
10407 frames in  5.000 seconds = 2081.400 FPS
10087 frames in  5.000 seconds = 2017.400 FPS
10142 frames in  5.000 seconds = 2028.400 FPS
10271 frames in  5.000 seconds = 2054.200 FPS
10304 frames in  5.000 seconds = 2060.800 FPS
10383 frames in  5.000 seconds = 2076.600 FPS
```

The numbers above are the result from changing the size of the window in the code of the Gears program. After reading about performance of OpenGL, my understanding is that the performance is not liner, which mean, performance is not proportional to the amount of things that we render. As we can see in the number above, when the screen was 300x300 it took more time to render each frame. I figured this out because to obtain the time that is used to render EACH frame, you have to do the inverse using FPS. For example, for the 1x1 when FPS was 2431, this meant that each frame took about .00041 seconds to render. However, then the screen size was 300x300, each frame took about .016 seconds to render. That is a huge difference. When the screen size was 2880x1800(which is the size of my full screen), each frame took about .00048 seconds to render which is pretty similar to when the screen was 1x1. For what I was reading this depends in many factors that can cause something called “Bottleneck”. Among these factors we find fragment processing, vertex processing, and CPU. For this case I think it has to do with fragment processing because the rendering time went up when I decreased the resolution.
However, not everything makes sense when going between those 3 sizes because from 1x1 to 300x300, we are increasing the number of pixels to render, therefore it makes sense that the time to render takes longer as we can see with the number above, but from 300x300 to full screen the time decreases instead of augmenting. Which makes me thing that now it has something to do with the CPU.

2) On some systems the frame rate is a small round number like 60 or 72 or 85 frames per second, and sometimes it is a large number, thousands or tens of thousands of frames per second. Explain why this occurs.

Because every system is different. Depends a few things such as Processing Power, Lighting, Shading, Ability to render objects, RAM, among others. Some systems' settings are able to render better because they have the capacity of making calculations faster. If you have a good CPU then the calculations will be done faster and therefore the GPU will be able to display faster.

3) Time required to complete the assignment.

I was not able to have the book before this assignment therefore I had to look online which took me about 2 hours because there is a lot of information that is not accurate or doesn't make sense. Reading about performance helped me realize that optimizing is not always easy because it has to do with many factors such as lighting. I previously took a computer animation class and lighting affected not only the performance but also the quality of the rendering because we had to manipulate some attributes like bumping and mixing textures, etc.