Project 3B – Ray Tracing 2: Triangles & Recursion

Due: March 19th (11:59pm)

Overview:

For this assignment you will be making a full-featured ray tracer. You can find several sample scenes posted on the course website as sample files, which you should be able to render. Your ray tracer should build off your code from Project 3A.

Partner:

You may finish Project 3B on your own, or work with a partner. If you work with a partner, you must explain in the report how labor was divided for part 3B.

Requirements:

It will be worth 85/100 points to get these basics features:

- Arbitrary camera placement, film resolution, and aspect ratio
- Arbitrary scenes with spheres, triangles (possible with vertex normals), and arbitrary background colors
- Arbitrary materials, including diffuse and specular shading, reflections, and refractions
- Point and directional lights
- Ambient lighting
- Shadows
- Recursion to a bounded depth

To get the full 100 points you need to add additional features from the list below (ask me if you have something in mind not on the list). It's okay if you need to extend the scene format in some way, just make sure you include a sample scene that shows off your new, cool features!

Additional Features:

The number in front is how many points a feature is worth. There will be partial credit for features that "sort of" work.

Scene specifications / Primitives:

(5) Cones and Cylinders
(5) Boxes and Planes
(5) Constructive Solid Geometry (union, difference, and intersection of primitives)
(10) Transformations on basic primitives (support 4×4 transformations or procedural ones! http://bit.ly/1vO4tnl)
(20) Procedurally generated terrain/heightfields with grid-marching acceleration
(25) Ray trace (transformed) implicit surfaces with ray-marching (https://rb.gy/o0sefm)

Complex Lighting
(5) Spot lights
(5) Area lights that produce soft shadows
(5) HDR, Bloom, & Tone mapping
(10) Ambient Occlusion
(20) Image-based lighting (e.g., HDR environment maps)

Sampling
(5) Jittered supersampling
(5) Adaptive supersampling (must show a speedup over non-adaptive)
(5) Motion Blur
(5) Depth of Field
(15) Physically-based camera lens simulation (match the assortment of lens commonly found in real cameras, e.g., https://en.wikipedia.org/wiki/Zoom_lens)

Materials
(5) Texture mapping
(5) Bump or Normal mapping
(5) Procedural texturing or normal mapping (checkerboard, wood, marble, mandelbrot set, etc..)

Miscellaneous
(5) User interface that shows the raytraced image being updated
(10) An acceleration structure: BVH, BSP, OctTree, etc. (measure the performance impact on different scenes!)
(10) Parallelize the raytracer (and analyze the performance gains as you add more processors!)
(25) Real-time SIMD/GPU Implementation using e.g., CUDA - http://bit.ly/1EplJpd

Submission Instructions:
Create a sample webpage with:

- A .zip file of all your code
- Several output images from your raytracer (including at some of the sample scenes)
- Brief description of your implementation, any issues you saw, and a list of any extra credit tasks you attempted
- Submission to Art Contest (optional)

For full credit on any of the features, you must include sample images showing the feature being used in an interesting/artistic fashion.

Hints:

- You should be able to leverage your previous raytracer code from 3A. Any extra credit work you did there should roll easily into this assignment. Try to be strategic about what extra features you choose to implement.

- A BVH is an easy way to render large, impressive scenes in a reasonable amount of time
- If you're running out of time focus on the easier options such as spot lights, boxes, planes, CSG and supersampling. That way you get some easy things completed well rather than rushing through something you don't have time to finish.

Extra Credit *(Optional, up to 20 points)*:

The assignment is graded out of 100 points. The required material is only 85 points, and you must complete an additional 15 points of work to receive full credit. If you have 100 points worth of working features, you may turn in up to 40 points worth of additional features to be graded as extra credit, but only at half the value (e.g., 140 points of perfect features would turn into 100+0.5*40=120 points). *You must explicitly identify which features you are submitting as extra credit* as these are the features that will count for half. As with all other features, be sure to document your extra credit working through text and illustrative images in your report.

Art Contest *(Optional, variable points)*:

Finally, there will be a class-wide art contest where you can submit your favorite rendering from your ray tracer. You may submit up to two images to the art content, and your submitted images must have been rendered by your raytracer, but you can include images from buggy versions if they are what looks best ☺ . Submitting at least one artistically interesting picture will receive 1 additional point of extra credit. An overall class winner (decided by the teaching staff) will receive 5 points.