Program 2

Parallel Hardware Ray Tracing

Due: 11:59:59 PM, September 16, 2011

1. **Part 1** (20 points): Run your program from assignment 1 on the TRaX simulator "simhwrt". If you followed the setup instructions online, this should be in a "sim" directory. The Makefile given in the LLVM_Trax/examples directory should have already built a TRaX assembly file for your program 1. To run the simulator, use the following command:

   ```
   ./simhwrt --no-scene --load-assembly <path to your prog01 rt-llvm.s>
   ```

   Redirect the output of this to a file and link this to your handin web page.

   `--no-scene` tells the simulator not to load any scene data in to its memory, since our scene is hard-coded in the ray tracer.

   `load-assembly` allows you to supply a program for the simulator to run.

   By default, the screen resolution will be 128x128, and the machine will run with a single core in a single TM (thread multiprocessor), with a default set of functional units and other resources. If successful, the simulator will automatically output "out.png" containing whatever your program wrote to the frame buffer. Some additional useful arguments to the simulator you may want to play with:

   `--width <number>`: sets the image width (x-resolution)

   `--height <number>`: sets the image height (y-resolution)

   `--num-thread-procs <number>`: sets the number of processors per TM

   `--num-cores <number>`: sets the number of TMs

   `--no-cpi`: will disable printing statistics about the simulation

   There are many other parameters to the simulator that can be tuned that we will talk about later in the course.

2. **Part 2: Shading** (60 points) Implement shading and cameras in your ray tracer. You must support a Pinhole-Camera and PointLight as described in class. Upgrade your Sphere class to support Lambertian shading with shadows for an arbitrary number of spheres and point lights in the scene.

   Required Image Your ray tracer should reproduce the image shown here containing four spheres and two point light sources.
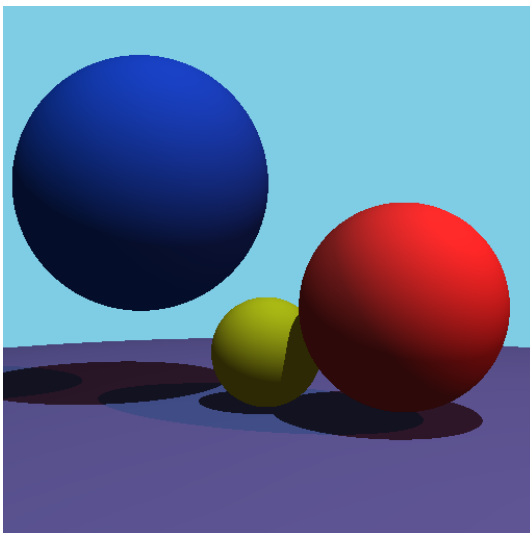
The details of the scene are as follows:

- Resolution: 512x512
- Eye point: [-24.f, -2.f, 5.2f]
- Lookat point: [1.f, 1.f, 2.4f]
- Up: [0.f, 0.f, 1.f]
- u_length: 0.194f (22° field of view)
- aspect ratio: 1.f
- 4 spheres:
  - Sphere 1: Center: [1.5f, 3.5f, 4.f], Radius: 2.4f, Material 1
  - Sphere 2: Center: [-0.5, -1.5, 2.f], Radius: 1.8f, Material 2
  - Sphere 3: Center: [0.5f, 1.0f, 1.f], Radius: 1.f, Material 3
  - Sphere 4: Center: [0.5f, 1.0f, -100.f], Radius: 100.f, Material 4
- 4 materials. Each material is a simple Lambertian material with Kd = 0.7 and Ka = 0.3
  - Material 1: Color: [0.1f, 0.3f, 0.9f]
  - Material 2: Color: [1.f, 0.2f, 0.2f]
  - Material 3: Color: [1.f, 0.9f, 0.1f]
  - Material 4: Color: [.4f, .4f, .7f]
- 2 point light sources:
  - Light 1: Position: [-30.f, -20.f, 80.f], Color: [.7f, .9f, .9f]
  - Light 2: Position: [-20.f, -50.f, 40.f], Color: [.6f, .1f, .1f]
- Ambient light: Color: [.6f, .1f, .1f]
- Constant background: Color: [0.5f, 0.8f, 0.9f]

Remember that you need to choose some way of preventing self-shadowing. In the reference image, I offset the hitpoint by a small epsilon in the normal direction. I hard-coded an epsilon of 1e-3; a good number for this may vary on your specific machine. If you choose a different method to prevent self-shadowing, your image may not exactly match the reference, which is fine.

3. **Creative Image** (20 points): Using Spheres and point-light sources (and if desired, any other type of geometry you wish to implement, such as planes, disks, etc.), produce an image of your choice that shows off your ray tracer and your creative skills.

4. **simhwrt output**: Link a file containing the output of running your program 1 code in the TRaX simulator

5. **Code listing**: Link your source code to your web page (preferably .tar). All of the code that you use should be included. You will not be graded on the quality of your code or comments, only on the presence of your source. We will verify that the code you hand in will produce the image(s) turned in.

6. **Time required**: How many hours did it take you to complete this assignment?

7. **Diffuculty**: What was the hardest part of this assignment, why?

You will not be graded on these last two items. They will be used to help improve the class in future assignments and in future years.

By midnight on the due date, you should send e-mail to teach-cs6965@list.eng.utah.edu with a URL for your assignment web page.