TECHNICAL DOCUMENTATION

Program Description

This program implements two methods: Ray marching and Ray tracing (taught in this semester). The ray tracer is used to recreate the silhouette of the window on the floor. Then Ray marching is used to generate the God rays from a point light source through the window.

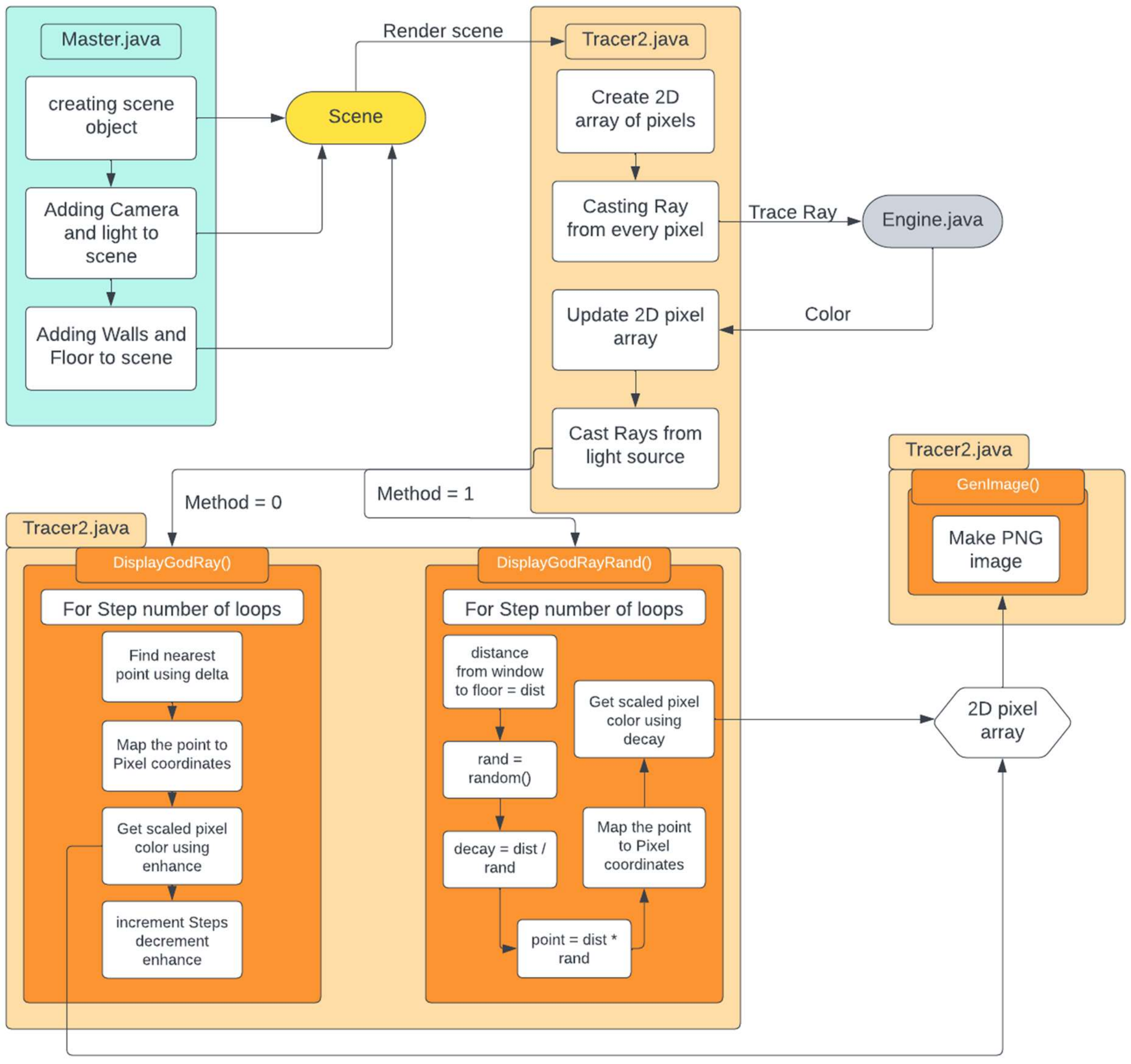
The ray tracer generates a 2D array of pixels that each hold a color value. It then emits rays from each pixel and finds the object it intersects. It then identifies whether a light ray casted from the light source can reach that intersection point without anything blocking its path.

The basic method involved in Ray marching is to cast rays from the light source to the floor and to track points on the ray at equal intervals. Each point on the ray holds a certain energy factor which becomes less when it is further away from the light source. Then we check if those points are visible in the view frame and if it is, then we map the point coordinates to the coordinates of the pixel, and scale its color with the energy factor of the ray point.

This step is repeated for multiple rays being casted through the window to the scene.

This method is further developed by using a random function to generate points at random locations on the ray, instead of a uniform distribution. The aim is to give the medium of the light rays a more foggy / dusty feel.

Overall System Structure


Master.java
creating scene object
Adding Camera and light to scene
Adding Walls and Floor to scene
Scene
Render scene
Tracer2.java
Create 2D array of pixels
Casting Ray from every pixel
Trace Ray
Engine.java
Color
Update 2D pixel array
Cast Rays from light source
Method = 0
Method = 1
Tracer2.java
DisplayGodRay()
For Step number of loops
Find nearest point using delta
Map the point to Pixel coordinates
Get scaled pixel color using enhance
increment Steps decrement enhance
DisplayGodRayRand()
For Step number of loops
distance from window to floor = dist
rand = random()
decay = dist / rand
point = dist * rand
Map the point to Pixel coordinates
Get scaled pixel color using decay
2D pixel array
Tracer2.java
GenImage()
Make PNG image

Overall Program Structure

Master.java:

It handles:

1. Generating the scene object
2. Generating all the structures and adding them to the scene

3. Generating the light source and camera and adding them to the scene object
4. It then calls the renderer in the Tracer2.java class with a completed scene object

Tracer2.java:

It handles:

1. Generating the 2D pixel array
2. Emitting each ray from every pixel and calling the engine.java class to perform the ray trace
3. Generates all the light rays for the Ray marching method.
4. Traces every point for the ray marching method and maps it to a pixel point
5. It then updates the colors in its 2D pixel array
6. Then it generates the image using the 2d Pixel array

Engine.java:

It handles:

1. Tracing and individual ray and computing its color
2. Collision detection for the ray and an object in the scene

Scene.java:

It handles:

1. The storage of all the objects in the scene
2. Defines the ambient and background color of the scene

Objects.java handles assigning properties that are common to all objects in the scene

Math3d.java contains all the 3D mathematical operations needed to perform computation for intersections, normal, etc. all classes and their methods access it during computations

Color.java contains all the methods and properties needed to define a RGB color

Camera.java contains the functions and properties to simulate a camera

Point3d.java contains the functions and properties to simulate a 3D Point

Vector3d.java contains the functions and properties to simulate a 3D Vector

Ray3d.java contains the functions and properties to simulate a 3D Ray

Light.java contains the functions and properties to simulate a point light source

Description of Key Data Structures

The only storage structures are:

1. Arraylists used by the Scene.java object to store all the triangles, and lights present in the scene. It is generated in Master.java. It is used by Master.java, Tracer2.java and Engine.java

2. 2D array to store the pixel colors. It is generated in Tracer2.java. It is used by Tracer2.java and Engine.java