# Ray Tracer

This is my ray tracer

## Successes

It did good

## Failures

Not so good

## Multiple light sources

Multiple light sources have been used in the scene. This has been implemented by iterating through a vector of all the lights in the scene and performing lighting calculations individually. Additionally, the distance of each light source has been included in the calculation, meaning that further away light sources contribute less light. Figure 1 below shows both light sources appearing reflected on a sphere, and figure 2 shows overlapping shadows caused by the multiple light sources.

A picture containing room

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Figure 2: overlapping shadows

Figure 1: double light on sphere

## Spotlight

The second light source in the scene has been implemented as a spotlight. When calculating the colour of a point, the shadow colour is used if the light source vector differs too greatly from the spot direction vector.

The calculation is not done for points already in shadow, so that no point is rendered with a “double shadow” from the same light (where points that would both be in shadow and are outside the spotlight appear much darker than regular shadows).

An example of a double shadow is shown below in figure 1, with a correct rendering on the right in figure 2.

A picture containing computer, drawing

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Figure 2: correctly rendered shadow

Figure 1: cone with double shadow

## Cylinder

Capped cylinders have been implemented as an extension of the SceneObject class. No caps are rendered underneath the cylinder, as the scene I was designing does not

## Cone

A cone object has been created by substituting the equation for a ray into the equation given in lectures for points on the surface of a cone, as seen below.

A screenshot of a cell phone

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The substitution was then rearranged into a quadratic equation of the form *at2 + bt + c = 0* and solved using the quadratic formula for the intersection points t1 and t2. The cone’s normal vector is also calculated using the equation given in the lecture notes.

## Textured cylinder

A cylinder has been textured with a wood texture, so that it looks like a wooden pole. The dot product of a pre-defined vector and the cylinder’s surface normal at the hit point is used to calculate the texture coordinate.

Since the inverse cosine of two angles can map to the same value on the range [-1, 1], an x-coordinate check has been used to ensure that values on the right side of the cylinder wrap around correctly. This conversion means that each angle from 0-360 degrees maps to a single coordinate.

A close up of a map

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## Anti-aliasing

Anti-aliasing has been implemented to smooth sharp changes in colour appearing in the ray-traced image. Each display pixel has been split into 4 quadrants, and rays are traced through the middle of each quadrant. The colour values of the split rays are then averaged to give the resultant pixel colour. This gives the render smoother edges, especially in places where there are sharp changes in colour (e.g. on shadow borders). No recursive splitting of quadrants has been implemented. The effects of anti-aliasing on the render can be seen in figures X and X+1.

 

## Refractive sphere

A sphere has been given refractive properties. An interior refracted ray is calculated using the hit point and the glm::refract method, which uses the object’s refractive index to determine how extreme the refraction should appear. This ray is then used to find the exiting ray, which gives the colour to display on the sphere’s surface at the original hit point using a recursive trace method call.

A picture containing room

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