Lecture 15: Recursive Ray Tracing

October 16, 2018
How about Reflections?

• Note reflections
• Granite tabletop
• Visible on base
• Also on handle

This is a featured picture on the English language Wikipedia (Featured pictures) and is considered one of the finest images. (October 2012)
Rationale for Interreflection

• Not all the light striking a surface comes directly from a light source.
• Some reflects from one surface onto another.
• We ignore diffuse reflected light:
  – Because it is small, and we can get away with it
  – Because it is very expensive to compute
• Specular reflection much more sensitive
  – Just consider reflections in previous image.
In the case of mirrors or shiny objects, this can have a major impact
Rays of Reflection

• To add interreflections, we need the light hitting the surface from the reflected viewing ray.

• Add to ambient, diffuse and specular
Computing $V_R$

- $R_V = 2(V \cdot N)N - V$
  - Just like $R_L$, but $V$ replaces $L$
- To be more detailed…
  
  $N_V = (V \cdot N)N$
  
  $T_V = N_V - V = (V \cdot N)N - V$
  
  $R_V = V + 2T_V = 2(V \cdot N)N - V$
Recursive Ray Tracing

• Generalize ray trace – light from a ray
  – Ray leaves surface from point of intersection
  – In the direction of $R_V$

• And how does it compute illumination?

• Exactly as we did it before, when …
  – Starting at the pixel
  – In the direction of $V$

• So ray tracing is recursive!
Illustrating Recursive Ray Tracing
Now in SageMath

- Complete implementation in SageMath
- Scene with three spheres and interreflection
- Can modify recursion depth

Illumination with Reflection for Spheres

Ross Beveridge, October 24, 2017

In this Notebook is a full implementation of ambient, diffuse and specular reflection - in color - for a scene consisting multiple light sources and multiple spheres. Also in this Notebook is an example of recursive ray tracing. In other words, one object may be seen to reflect on the surface of another. The first bit of code that follows is book keeping to help setup libraries and display defaultst. Read on below to get more about the substance of this ray tracer.
Scene
Rendering 6 bounces at 2048 x 2048 (about an hour!)
Careful Review of Notebook

Printed copies available in lecture and PDF is available on the course website.