Shading values for colored surfaces

- Simplest:
  - Use appropriate shading model in 3 channels, instead of one
  - Implies red albedo, green albedo, blue albedo, etc.
  - Works because the shading model is independent of wavelength.
  - Can lead to somewhat inaccurate colour reproduction in some cases - particularly coloured light on coloured surfaces
- Better
  - Use appropriate shading model at many different wavelength samples - 7 is usually enough
  - Estimate receptor response in eye using sum over wavelength
  - Set up pixel value to generate that receptor response

Monitor Gamma

A typical image encoding is **NOT** linear. Often a gamma correction is included. This leads to no end of confusion.

A "gamma" corrected image is ready to drive a CRT monitor, and has advantages that quantization (8 bits) errors are *roughly* uniformly distributed--that fact that this works is a convenient accident.

Monitor Gamma

Due to the physics involved, CRT monitor brightness is proportional to voltage^(2.5)

This is further hacked to give the "standard" gamma of 2.2

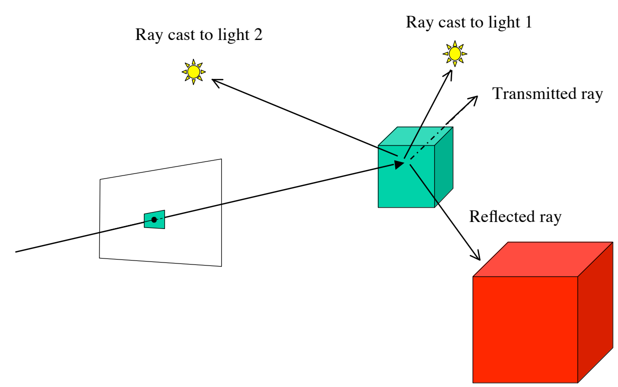
So, if an image looks good on a CRT, it is likely to be non-linear by pow(1/2.2)

LCD--more linear, but then hardware/software can be hacked to be like CRT

Confusing? Yes!

Recursive ray tracing

H&B, page 597



Recursive ray tracing rendering algorithm

- Cast ray from pinhole (projection center) through pixel, determine nearest intersection
- Compute components by casting rays
  - to sources = shadow ray (diffuse and for specular lobe)
  - along reflected direction = reflected ray
  - along transmitted dir = refracted ray
- Determine each component and add them up with contribution from ambient illumination.
- To determine some of the components, the ray tracer must be called **recursively**.

Recursive ray tracing rendering (cont)

- Recursion needs to stop at some point!
- Contributions die down after multiple bounces---there is no such thing as a perfect reflector---so we either set mirror reflections to be less than 100% (even if the user asks for 100%), or simply include an attenuation factor for each new ray.
- Can also model absorption due to light traveling in medium
  - Usually ignored in air, but depends on the application
  - Translucent absorption is exponential in depth

$$I = I_0 e^{-\alpha d}$$

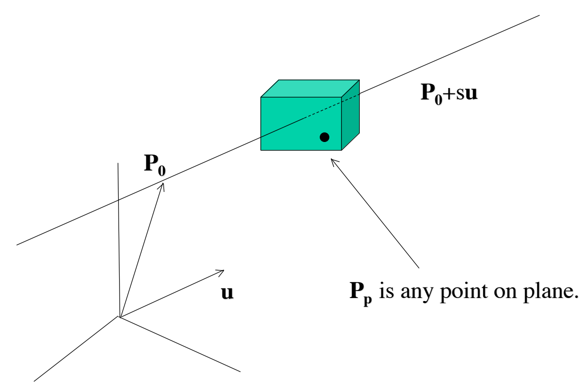
- Recursion is stopped when contributions are too small
  - need to track the cumulative effect
  - common to also limit the depth explicitly

Mechanics

- Primary issue is intersection computations.
  - E.g. sphere, triangle.
- Polygon (should feel familiar!)
- Find point on plane of polygon and then determine if it is inside
  - One way is to make an argument with angles
  - Another way---thinking of the polygon as a surface of a polyhedra---is to check if the point is on the inside side of each of the other planes of the polyhedra.
- Sphere, relatively simple algebra.

Poly details

Review! (recall picking)



Poly details

Review! (recall picking)

To find the intersection of the ray and the plane, solve:

$$\left(\mathbf{P}_0 + s\mathbf{u} - \mathbf{P}_\mathrm{p}\right) \bullet \mathbf{n} = 0$$

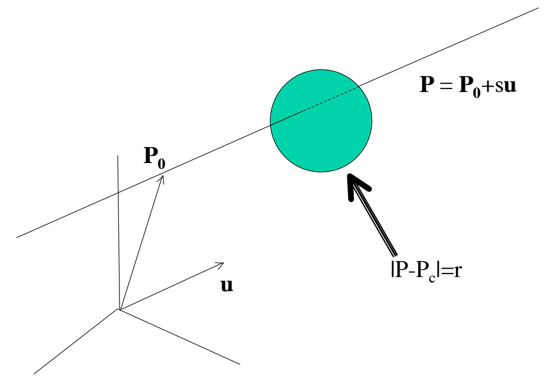
Once you have the point of intersection, $\mathbf{P}_\mathbf{i}$, test that it is inside by testing against all other faces.

$$\left(\mathbf{P}_\mathrm{i} - \mathbf{P}_\mathrm{p}\right) \bullet \mathbf{n} < 0$$

Note that **n** and $\mathbf{P}_\mathbf{p}$ are now from those *other* faces.

Sphere details (H&B, 602)

May be helpful for grad version of A6.



Sphere details (H&B, 602)

May be helpful for grad version of A6.

$$\left|\mathbf{P}_0 + s\mathbf{u} - \mathbf{P}_\mathrm{c}\right| = r$$

$$\left|\Delta\mathbf{P} + s\mathbf{u}\right| = r$$

$$(\Delta\mathbf{P} + s\mathbf{u}) \bullet (\Delta\mathbf{P} + s\mathbf{u}) = r^2$$

$$\Delta\mathbf{P} \bullet \Delta\mathbf{P} - r^2 + 2s\Delta\mathbf{P} \bullet \mathbf{u} + s^2\mathbf{u} \bullet \mathbf{u} = 0$$

The last expression is easily solved using the quadratic equation. If the discriminant is negative (complex solutions), then the ray does not intersect the sphere.

Sphere details (H&B, 602)

May be helpful for grad version of A6.

Recall that if: $as^2 + bs + c = 0$

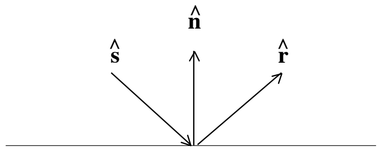
The “discriminant” is: $b^2 - 4ac$

The solution is: $s = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Note that in the book, **u** is a unit vector, so **u•u**=1, thus a=1, and b has a factor of 2 that is removed by dividing by 2a=2, to get equation 10-71.

Review!

Reflection Details



$\hat{\mathbf{s}} + \hat{\mathbf{r}} = k\hat{\mathbf{n}}$ and $\hat{\mathbf{n}} \bullet \hat{\mathbf{s}} = \hat{\mathbf{n}} \bullet \hat{\mathbf{r}}$

$\hat{\mathbf{n}} \bullet \hat{\mathbf{s}} + \hat{\mathbf{n}} \bullet \hat{\mathbf{r}} = k \;\Rightarrow\; k = \mathbf{2}\hat{\mathbf{n}} \bullet \hat{\mathbf{s}}$

So $\hat{\mathbf{r}} = \mathbf{2}(\hat{\mathbf{n}} \bullet \hat{\mathbf{s}})\hat{\mathbf{n}} - \hat{\mathbf{s}}$