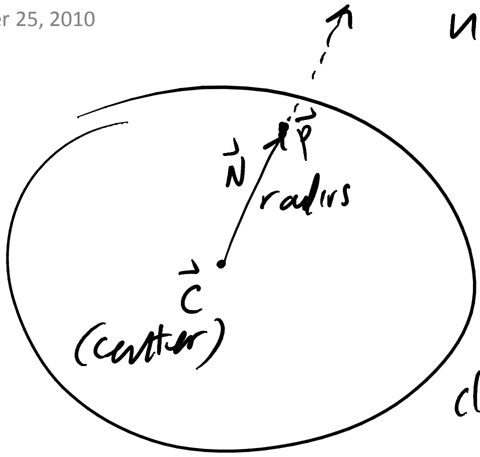
ray/sphere intersection

Monday, October 25, 2010
9:04 AM

$\vec{N}$ sphere surface normal: $\dfrac{\vec{p}-\vec{c}}{\|\vec{p}-\vec{c}\|} = \vec{N}$ given $\vec{p}$, point on surface of sphere



class sphere_t: public object_t

subclass of object_t

in model.txt:

```
sphere name
{
    center x y z
    radius r
}
```

given $\vec{c}$, $\vec{N}$

$$\vec{p} = \vec{c} + r\vec{N}$$

any point on sphere

parametric equation of sphere

parametric equation of ray is:

$$ray = \vec{pos} + t\,\vec{dir}, \quad t \geq 0$$

parameter t

— equation of sphere:

center

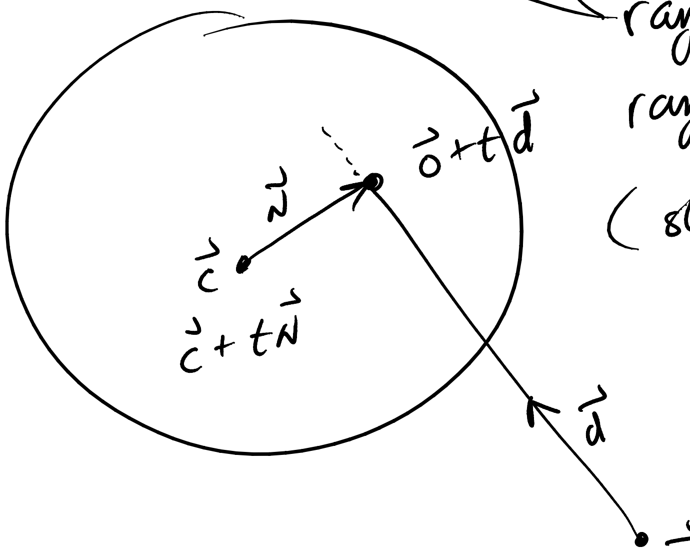
$$(\vec{x} - \vec{c}) \cdot (\vec{x} - \vec{c}) = r^2$$

$$\vec{x}(t) = \underbrace{\vec{pos} + t\,\vec{dir}}_{\text{substitute in place of } \vec{x}}$$

$$(\vec{pos} + t\,\vec{dir} - \vec{c}) \cdot (\vec{pos} + t\,\vec{dir} - \vec{c}) = r^2$$

$$(\vec{o} + t\vec{d} - \vec{c}) \cdot (\vec{o} + t\vec{d} - \vec{c}) = r^2$$

ray.o : ray origin
ray.d : ray dir
(should really have a ray class that stores this)



$$(\vec{o} + t\vec{d} - \vec{c}) \cdot (\vec{o} + t\vec{d} - \vec{c}) = r^2$$

solve for t

known, from ray

known, from sphere obj

known, from sphere obj

sphere, oh,

oh,

$$At^2 + Bt + C = 0 \quad : \quad \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$

always the smaller of the two roots

$A = \vec{d} \cdot \vec{d}$

$B = 2(\vec{o} - \vec{c}) \cdot \vec{d}$

$C = (\vec{o} - \vec{c}) \cdot (\vec{o} - \vec{c}) - r^2$

set D to this to calculate once

if ($B^2 - 4AC \geq 0.0$)

{

do this

$$t = \frac{-B - \sqrt{B^2 - 4AC}}{2A}$$

do this only if

$B^2 - 4AC \geq 0$

}

else no intersection.

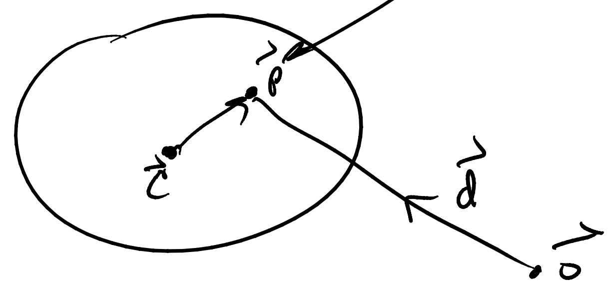
if we have intersection,

last_hit $= \vec{o} + t\vec{d} = \vec{p}$

also, calculate sphere normal :

last_hit = $\vec{o} + t\vec{d} = \vec{p}$

also, calculate sphere normal:



$$\vec{N} = \frac{1}{r}(\vec{p} - \vec{c})$$

in ray_trace, use $\vec{p}$ = last_hit &

$\vec{N}$ to calculate:

a) color at surface

b) reflection vector