Ray Tracing 2

Week 12 B

CS5600 ***Computer Graphics***

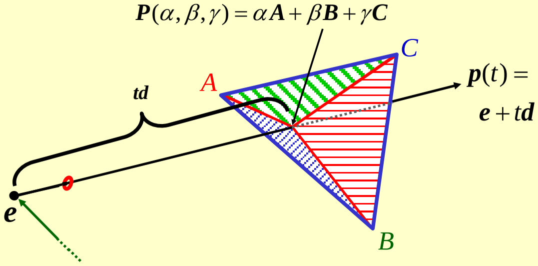
From Rich Riesenfeld

Spring 2008

What is the Projection Matrix?

Solving for $\boldsymbol{p}(t) \cap \triangle \boldsymbol{ABC}$

$$\boldsymbol{P}(\alpha,\beta,\gamma) = \alpha\mathbf{A} + \beta\mathbf{B} + \gamma\mathbf{C}$$

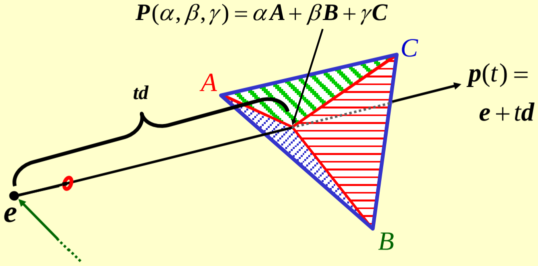


What about texturing?

We know the intersection point, *p*, what about (*s*,*t*)?

Solving for $\boldsymbol{p}(t) \cap \triangle \boldsymbol{ABC}$

$$\boldsymbol{P}(\alpha,\beta,\gamma) = \alpha\mathbf{A} + \beta\mathbf{B} + \gamma\mathbf{C}$$



Shirley's *ray* $\cap$ Polygon Method

Let $\boldsymbol{p}(t) = \boldsymbol{e} + t\boldsymbol{d}$ be a ray.

For any object defined by f,

we are looking for

$$\mathrm{f}\left(\boldsymbol{p}(t)\right) = \mathrm{f}\left(\boldsymbol{e} + t\boldsymbol{d}\right) = 0,$$

for intersection points

Shirley's $ray \cap$ Polygon Method

*f (p(t)) = f (e + t**d**) = 0*

Equation to test point in plane:

$(p - p_1) \text{ dot } n = 0$

Plug ray-equ into plane-equ:

$(e + t\mathbf{d} - p_1) \text{ dot } n = 0$

Shirley's $ray \cap$ Polygon Method

$(e + t\mathbf{d} - p_1) \text{ dot } n = 0$

$(t\mathbf{d} + e - p_1) \text{ dot } n = 0$

$(t\mathbf{d} \text{ dot } n) + (e - p_1) \text{ dot } n = 0$

$t\mathbf{d} \text{ dot } n = (p_1 - e) \text{ dot } n$

$t = (p_1 - e) \text{ dot } n \, / \, \mathbf{d} \text{ dot } n$

Need to check if p in inside polygon

$ray \cap implicit\_object$

Let $\boldsymbol{p}(t) = \boldsymbol{e} + t\boldsymbol{d}$ be a ray.

For any object defined by

$f(x, y, z) = 0$, we are looking for

$f\left(\boldsymbol{p}(t)\right) = f\left(\boldsymbol{e} + t\boldsymbol{d}\right) = 0$,

for intersection points

$ray \cap sphere$ - 1

For sphere with center $\boldsymbol{c} = (c_x, c_y, c_z)$,

$(\boldsymbol{p} - \boldsymbol{c}) \bullet (\boldsymbol{p} - \boldsymbol{c}) - R^2 = 0$

is a vector eq with $\boldsymbol{p} = (p_x, p_y, p_z)$.

$\therefore \quad (\boldsymbol{e} + t\boldsymbol{d} - \boldsymbol{c}) \bullet (\boldsymbol{e} + t\boldsymbol{d} - \boldsymbol{c}) - R^2 = 0$

$ray \cap sphere$ - 2

Collecting terms,

$\boldsymbol{d} \bullet \boldsymbol{d}\, t^2 + 2\boldsymbol{d} \bullet (\boldsymbol{e} - \boldsymbol{c}) t + (\boldsymbol{e} - \boldsymbol{c}) \bullet (\boldsymbol{e} - \boldsymbol{c}) - R^2 = 0$

Hence, $t =$

$$\frac{-\boldsymbol{d} \bullet (\boldsymbol{e} - \boldsymbol{c}) \pm \sqrt{\left(\boldsymbol{d} \bullet (\boldsymbol{e} - \boldsymbol{c})\right)^2 - (\boldsymbol{d} \bullet \boldsymbol{d})\left((\boldsymbol{e} - \boldsymbol{c}) \bullet (\boldsymbol{e} - \boldsymbol{c}) - R^2\right)}}{(\boldsymbol{d} \bullet \boldsymbol{d})}$$

And, unit normal is $\boldsymbol{n} = {(\boldsymbol{p} - \boldsymbol{c})}/{R}$

$ray \cap sphere$

Sign of: $\left(\boldsymbol{d} \bullet (\boldsymbol{e} - \boldsymbol{c})\right)^2 - (\boldsymbol{d} \bullet \boldsymbol{d})\left((\boldsymbol{e} - \boldsymbol{c}) \bullet (\boldsymbol{e} - \boldsymbol{c}) - R^2\right)$

if sign < 0 : ray misses sphere
sign = 0: ray is tangent to sphere
sign > 0: 2 intersections

Which to use?

Lecture Week 12 B

End

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