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Selected Problem Set 8

1. Given the ray $\vec{r}(t)=\vec{e}+\vec{d}\,t$ where $\vec{e}=(3,3,3)^T$ and $\vec{d}=(-1,-1,-1)^T$, find the minimal value of t for which the ray intersects a generic sphere.

   Pose $a=\|\vec{d}\|^2$, $b=\vec{e}\cdot\vec{d}$, $c=\|\vec{e}\|^2-1$ *and proceed to solve for variable* t *as* $at^2+2bt+c=0$ *as* $t_0=\frac{-b}{a}\pm\frac{\sqrt{b^2-ac}}{a}=3\pm\frac{\sqrt{3}}{3}$ *. The minimal value is* $3-\frac{\sqrt{3}}{3}$ *.*

2. Give the 3D coordinates of the intersection point on the sphere.

   Put the smallest value of t *in the equation of the ray to obtain* $(3,3,3)+\left(3-\frac{\sqrt{3}}{3}\right)(-1,-1,-1)=\frac{\sqrt{3}}{3}(1,1,1)$

3. Give the sphere surface normal at the intersection point.

   For the sphere, the normal vector at the hit point is the hit point interpreted as a vector: $\vec{n}=\frac{\sqrt{3}}{3}(1,1,1)$ *.*

4. Given a light located at $(0,0,10)^T$, give the unit vector from the intersection point to the light source.

   The vector from the intersection point to the light source position is: $\vec{s}=L-\vec{r}(t_0)=\left(\frac{-\sqrt{3}}{3,}\,\frac{-\sqrt{3}}{3},\,10-\frac{\sqrt{3}}{3}\right)$

5. Compute $\vec{r}$, the vector of specular reflection at the intersection point.

   $\vec{r}=\vec{r}(t_0)-2(\vec{r}(t_0)\cdot\vec{n})\vec{n}=\frac{-\sqrt{3}}{3}(1,1,1)$