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diagram: $C(0\ 10)$, $N(0\ 1)$, $P(375\ 199)$, $-d$, θ_i, θ_r, R, $L(x, 2)$

3a)

212
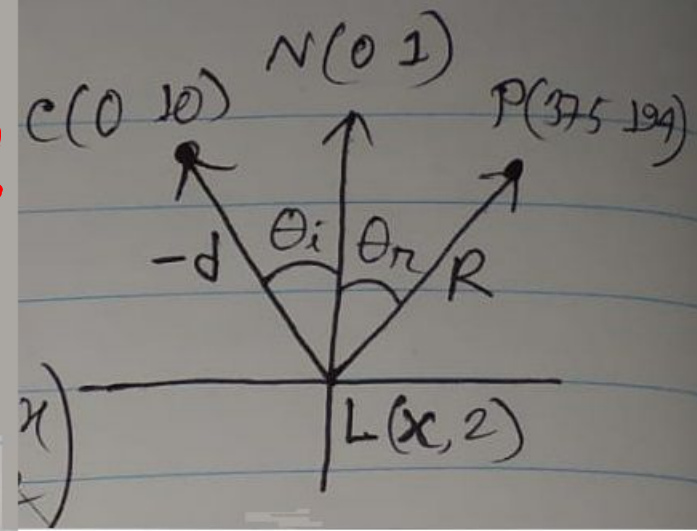
$$-d = C - L = \begin{pmatrix} -x \\ 8 \end{pmatrix} \quad \therefore \quad d = \begin{pmatrix} x \\ -8 \end{pmatrix}$$

$$R = d - 2(N \cdot d)N = \begin{pmatrix} x \\ -8 \end{pmatrix} - 2(-8)\begin{pmatrix} 0 \\ 1 \end{pmatrix} = \begin{pmatrix} x \\ -8 \end{pmatrix} + \begin{pmatrix} 0 \\ 16 \end{pmatrix}$$

$$= \begin{pmatrix} x \\ 8 \end{pmatrix}$$

We know, $P = L + \ell R$

$$\Rightarrow \begin{pmatrix} 375 \\ 194 \end{pmatrix} = \begin{pmatrix} x \\ 2 \end{pmatrix} + \ell \begin{pmatrix} x \\ 8 \end{pmatrix}$$

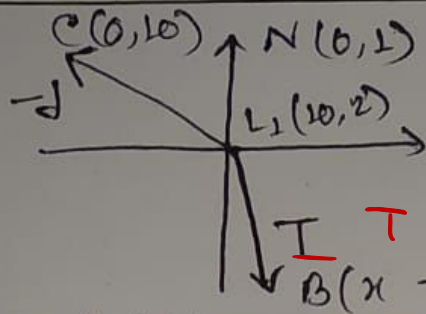$$\Rightarrow \begin{pmatrix} 375 \\ 194 \end{pmatrix} = \begin{pmatrix} x + \ell x \\ 2 + 8\ell \end{pmatrix}$$

$$\therefore \quad 2 + 8\ell = 194 \Rightarrow \ell = \frac{192}{8} = 24$$

$$\therefore \quad x + 24x = 375 \Rightarrow x = \frac{375}{25} = 15.$$

$$\therefore \quad L = (15\ \ 2)^T$$

$C(0,10)$ $N(0,1)$

$-d$ $L_1(10,2)$

$\uparrow$ T normalized

I

$B(x-8)$

other way around

$$\eta = \frac{1.330}{1.000277} = 1.3296$$

d has to be normalized

On

3b) $\quad -d = C - L_1 = \begin{pmatrix} -10 \\ 8 \end{pmatrix} \quad \therefore d = \begin{pmatrix} 10 \\ -8 \end{pmatrix}$

$$T = \left(-\eta(N \cdot d) - \sqrt{1 - \eta^2(1-(N \cdot d)^2)} \right) N + \eta d$$

$$= \left(-1.3296(-8) - \sqrt{1 - 1.3296^2 \, (1-(-8)^2)} \right) \otimes \begin{pmatrix} 0 \\ 1 \end{pmatrix} + 1.3296 \begin{pmatrix} 10 \\ -8 \end{pmatrix}$$

$$= \begin{pmatrix} 13.296 \\ -10.6006 \end{pmatrix}$$

Now, $B = L_1 + t\,T \Rightarrow \begin{pmatrix} x \\ -8 \end{pmatrix} = \begin{pmatrix} 10 \\ 2 \end{pmatrix} + t \begin{pmatrix} 13.296 \\ -10.6006 \end{pmatrix}$

$\Rightarrow -8 = 2 - t \times 10.601 \quad \Rightarrow t = 0.9433$

$\Rightarrow x = 10 + t \times 13.296 \quad \Rightarrow x = 22.54$

$$\therefore B = (22.54 \quad -8) \quad \underline{\underline{A}} \therefore$$

3c)

Λ/Λ

Crystal clear ice : Refractive index ~~will be~~ of Crystal clear ice is slightly lower ~~to the refract~~ ~~ive ray~~ than refractive index of water. So the refractive ray will slightly move away from the normal vector. Thus the angle between ~~the~~ normal vector and refractive ray θ_2 will slightly increase.

Diamond : Refractive index of diamond is much higher than refractive index of water. So the refractive ray will significantly move towards the normal vector. Thus the angle between the normal vector and refractive ray θ_2 will significantly decrease.

2a)
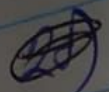
Picture is $640 \times 480 = 307200$ pixels.

Time for each ray intersection test = 0.0001 s

Each ray is reflected 3 times and shadow testing is enabled.

Total time required = $2 \times 4 \times 307200 \times 0.0001 s = 245.76 s$ ✓

2b)

In this case ray will be recursively reflected,

So, time required = $2 \times (100^3 + 100^2 + 100 + 1) \times 307200 \times 0.0001 s$

$= 62060605.44 s$ ✓

Explain more.

2c)

Number of reflections per intersection = n

recursion depth = n

So runtime = $O(n^n)$ ✓   Explain more.

2d) If a ray hits an object at point $\vec{x}$, then it is

likely that ~~that~~ other reflected rays will hit the object near $\vec{x}$. So each time in stead of calculating ~~the~~ intersection point, we can define a certain rating around point $\vec{x}$ ~~$\cancel{}$~~ and ~~~~eaten~~~~ we can assume other intersection points will be in this rating. So we can save ~~the~~ time for intersection test. asymptotic run time stays the same.

Practical Part

Assignment 1) Implementing ray tracing algorithm
a)2/2
b)1/2 (only one picture)
c)0.5/2 (original code changed, weird code)

3.5/6

Theoretical Part

Assignment 2) Rendering Complexity
a)0.5/0.5
b)1/1
c)0.5/0.5
d)0.5/1

Assignment 3) Plane reflection
a)2/2
b)0/1
c)1/1

5.5/5 (originally 7 but we only count 5 for the 50% margin due to tasks 2c, 3b and 3c)