Problem Set 3

16825 Learning for 3D Vision (Spring 2024)
https://piazza.com/cmu/spring2024/16825

OUT: Feb. 21, 2024
DUE: Mar. 13, 2024 11:59 PM
Instructor: Shubham Tulsiani
TAs: Anurag Ghosh, Ayush Jain, Bharath Raj, Ruihan Gao, Shun Iwase

1. **[10 pts]**

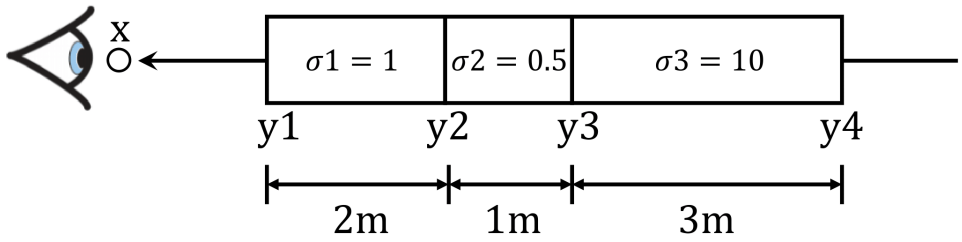

Figure 1: A ray through a non-homogeneous medium. The medium is composed of 3 segments ($y1y2$, $y2y3$, $y3y4$). Each segment has a different absorption coefficient, shown as $\sigma_1, \sigma_2, \sigma_3$ in the figure. The length of each segment is also annotated in the figure (1m means 1 meter).

As shown in Figure 1, we observe a ray going through a non-homogeneous medium. Please compute the following transmittance:

- $T(y1, y2)$
- $T(y2, y4)$
- $T(x, y4)$
- $T(x, y3)$

Solution

We know,

$$T(a,b) = e^{-\sigma(y)dy} \tag{1}$$

Therefore we can find transmittance of the 3 segments as,

$$T(y_1, y_2) = e^{-\sigma_1 * 2} = e^{-2} \tag{2}$$

$$T(y_2, y_3) = e^{-\sigma_2 * 1} = e^{-0.5} \tag{3}$$

$$T(y_3, y_4) = e^{-\sigma_3 * 3} = e^{-30} \tag{4}$$

We also assume that there is a vacuum in the segment of x to y1, therefore,

$$T(x, y1) = 1 \tag{5}$$

Now finding answers using multiplicative property of transmittance-
1) $T(y_1, y_2)$

$$T(y_1, y_2) = e^{-2} = 0.135 \tag{6}$$

2) $T(y_2, y_4)$

$$T(y_2, y_4) = T(y_2.y_3) \times T(y_3, y_4) = e^{-0.5} \times e^{-30} = e^{-30.5} = 5.68 \times 10^{-14} \tag{7}$$

3) $T(x, y_4)$

$$T(X, y_4) = T(x.y_1) \times T(y_1.y_2) \times T(y_2.y_3) \times T(y_3, y_4) = 1 \times e^{-2} \times e^{-0.5} \times e^{-30} = e^{-32.5} = 7.68 \times 10^{-15} \tag{8}$$

3) $T(x, y_3)$

$$T(x, y_4) = T(x.y_1) \times T(y_1.y_2) \times T(y_2.y_3) = 1 \times e^{-2} \times e^{-0.5} = e^{-2.5} = 0.082 \tag{9}$$