University of Calgary

CPSC 453:

Introduction to Computer Graphics,

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Assignment #2

For
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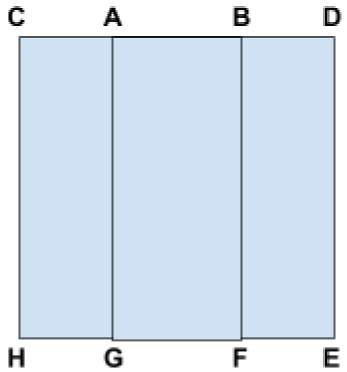
Question 1: Displaying an Image

A.



From the question we have known the photo has the size $3168 * 4752$ pixels. If we want to fully fit it in the center of a square OpenGL window and undistorted, we pick the height as the side of the square since it the height is the longest side of the picture and also the smallest side required for the square. So that

$CH = CD = DE = HE = AG = BF = 4752$ and $AB = GF = 3168$

To calculate the corresponding normalized coordinates for four corners:

$\frac{AB}{CD} = \frac{AB_{normalized}}{2.0} \Rightarrow \frac{3168}{4752} = \frac{AB_{normalized}}{2.0} \Rightarrow AB_{normalized} \approx 1.33$

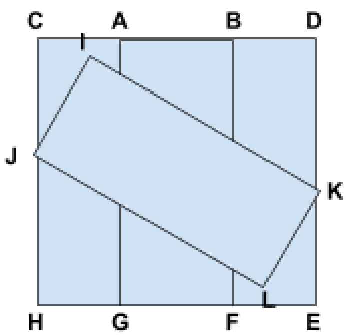
Then we have,

$A_x = G_x = -(\frac{AB_{normalized}}{2}) \approx -0.67 \qquad A_y = B_y = 1$

$B_x = F_x = \frac{AB_{normalized}}{2} \approx 0.67 \qquad G_y = F_y = -1$

So that, the (x, y) normalized device coordinates for A, B, G and H are $(-0.67,\ 1)$, $(0.67,\ 1)$, $(-0.67,\ -1)$, $(0.67,\ -1)$.

B.



We use rotation matrix to calculate the coordinate for L, I, J and K.

$$\begin{pmatrix} \cos(60) & -\sin(60) & 0 \\ \sin(60) & \cos(60) & 0 \\ 0 & 0 & 1 \end{pmatrix} \times \begin{bmatrix} X \\ Y \\ 1 \end{bmatrix}$$

After we plug $A(-0.67,\ 1),\ B(0.67,\ 1),\ G(-0.67,\ -1),\ F(0.67,\ -1)$ we get the approximate corresponding coordinates are $J(-1.20,\ -0.08)$, $I(-0.53,\ 1.08)$, $L(0.53,\ -1.08)$, $K(1.20,\ 0.08)$.

Question 2: Color Effects

A. From the graph we have known that the relative absorbance for "pure green" is approximately $0.856 - 0.355 = 0.501\lambda$ higher than "pure red" light and "pure blue" is approximately $0.856 - 0.09 = 0.766\lambda$. In order to have the both color in the same perceived intensity by average human observer, the ratio of "pure red" to "pure green" needs to be $1 : (1/0.355) \approx 1 : 2.394$ and the ratio of "pure green" to "pure blue" light needs to be $1 : (1/0.09) \approx 1 : 11.11$.

B. From the question we have known that the relative absorbance for "pure blue", "pure green" and "pure red" are 0.09λ, 0.856λ and 0.355λ. Then we can calculate the weighting by:

$$Red = \frac{0.355\lambda}{0.355\lambda+0.09\lambda+0.856\lambda} \approx 0.271$$

$$Green = \frac{0.856\lambda}{0.355\lambda+0.09\lambda+0.856\lambda} \approx 0.66$$

$$Blue = \frac{0.09\lambda}{0.355\lambda+0.09\lambda+0.856\lambda} \approx 0.069$$

Then we have $L = 0.271R + 0.656G + 0.069B$

Question 3: Edge Effects

A. The difference between GL_TEXTURE_2D and GL_TEXTURE_RECTANGLE is that GL_TEXTURE_2D takes in the range of texture coordinates as (0.0, 0.1) * (0.0, 1.0) whereas GL_TEXTURE_RECTANGLE takes in the range of texture coordinates as (0.0, picture_width) * (0.0, picture_height).

B. The image pixels for every display pixel the image occupies on the screen is:

$$(3168 * 4752) / ((3168 / 4752) * 1000 * 1000) \approx 23\ pixels$$

C. The answer depends, the discrepancy from part B has minor affect to the output of the Sobel edge filter since 667 * 1000 pixels is still a fairly large window compare with 3168 * 4752 pixels. However, some details in the image may disappear if this ratio gets too large.

Question 4: Gaussian Blur

A. We know that $G(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-x^2/2\sigma^2}$ for normalized 1D Gaussian. We then pass x = 0, 1, 2, and 3 into the function and we get:

$$G(0) \approx 0.285 \quad G(1) \approx 0.221 \quad G(2) \approx 0.103 \quad G(3) \approx 0.029$$

B. When $x = 0,\ G(0) = 0.4$, by plug into theses values and try them in the calculator we get σ is approximately 1.0. When $x = 1,\ G(1) = 0.24$, by plug into theses values and try them in the calculator we get σ is approximately 1.1. When $x = 2,\ G(2) = 0.06$, by plug into theses values and try them in the calculator we get σ is approximately 1.0.

C. From the previous question we can conclude that the σ for the most of points is approximately 1.0. We then try to summarize the σ for 3 and 7 points discrete Gaussian, they have σ approximately 0.7 and 1.4. If we make it into a graph we can find a pattern:

Points	3	5	7
σ	0.7	1.0	1.4

We can notice that in when points increase by 2, the σ increase 0.3, 0.4, 0.5 ….

Points	3	5	7	9
σ	0.7	1.0	1.4	1.9

Then we use $\sigma = 1.9$ to calculate the 9 points we get 0.02, 0.06, 0.12, 0.18, 0.21, 0.18, 0.12, 0.06 and 0.02.