Nptel Online Certification Course
Indian Institute of Technology Kharagpur
Computer Vision
Assignment - Week 8

Number of questions: 10 **Total marks: 10x2=20**

QUESTION 1: **Type: MCQ**

Consider a pixel whose RGB component is (30,10,20). What is the saturation value of this pixel in HSV color space?

a) 0.4

b) 0.3

c) 0.6

d) 0.5

Correct Answer: d)
Detailed Solution:
$V = \frac{R+G+B}{3} = 20.$
$S = 1 - \frac{min(R,G,B)}{V} = 0.5.$

QUESTION 2: **Type: Numeric**

Given Bayer's pattern.

$$\text{Bayer's Pattern} = \begin{bmatrix} G_1 & R_2 & G_3 & R_4 & G_5 \\ B_6 & G_7 & B_8 & G_9 & B_10 \\ G_{11} & R_{12} & G_{13} & R_{14} & G_{15} \\ B_{16} & G_{17} & B_{18} & G_{19} & B_{20} \\ G_{21} & R_{22} & G_{23} & R_{24} & G_{25} \end{bmatrix}$$

$$\text{Corresponding CFA values} = \begin{bmatrix} 10 & 14 & 18 & 24 & 30 \\ 15 & 25 & 35 & 45 & 55 \\ 24 & 45 & 150 & 225 & 168 \\ 65 & 87 & 124 & 100 & 144 \\ 34 & 225 & 200 & 235 & 245 \end{bmatrix}$$

Interpolate R_{17} using billinear interpolation.

Correct Answer: 135

Detailed Solution: $R_{17} = \frac{R_{12}+R_{22}}{2}$

QUESTION 3: **Type: MCQ**

Consider a pixel p in RGB space given by $\begin{bmatrix}100\\150\\90\end{bmatrix}$. What is the corresponding value of the pixel p in CMY space?

a) $\begin{bmatrix}155\\105\\165\end{bmatrix}$

b) $\begin{bmatrix}200\\150\\190\end{bmatrix}$

c) $\begin{bmatrix}105\\150\\165\end{bmatrix}$

d) $\begin{bmatrix}125\\105\\190\end{bmatrix}$

Correct Answer: a)

Detailed Solution:

$$\begin{bmatrix}C\\M\\Y\end{bmatrix} = \begin{bmatrix}1\\1\\1\end{bmatrix} - \begin{bmatrix}R\\G\\B\end{bmatrix} = \begin{bmatrix}155\\105\\165\end{bmatrix}.$$

QUESTION 4: **Type: MSQ**

Which of the following statements are correct?

a) The saturated colors are at the boundary.

b) Any spectral signal can be thought of as a linear combination of very many monochromatic lights, with the linear coefficient given by the spectral power at each wavelength.

c) The green channel is more likely to be aliased.

d) In CFA the luminance (green) channel sampled at a higher rate than the chrominance (red and blue) channels.

Correct Answer: a), b), d)

Detailed Solution:

The green channel is less likely to be aliased, and details are preserved better in the green channel than in the red and blue channels.

QUESTION 5: **Type: MSQ**

Given the coordinates in the normalized x-y chromaticity space of three primary colors as $(2/3, 1/3)$, $(1/5, 3/4)$, and $(1/6, 1/10)$, compute the corresponding maximally saturated color in the x-y chromaticity space preserving the same hue and intensity for the given point $(0.31, 0.27)$ in x-y chromaticity space. Evaluate all the results upto three decimal places.

a) approximately $(0.489, 0.308)$

b) approximately $(0.708, 0.186)$

c) approximately $(0.189, 0.108)$

d) approximately $(0.208, 0.286)$

Correct Answer: c), d)

Detailed Solution: Given the three primary colors as $R = (2/3, 1/3)$, $G = (1/5, 3/4)$, and $B = (1/6, 1/10)$ in x-y chromaticity space. We have white point $w = (1/3, 1/3)$ and a given point $q = (0.31, 0.27)$. If you move the point radially to the gamut edge, you will find a Maximum Saturation given a hue. Intersection of point between the line formed by an edge of the triangle and wq, will be the required answer.

Use the projective space concept of cross product between two points will give you a line passing through the points.

$BG = (1/6, 1/10, 1) \times (1/5, 3/4, 1) = (-0.65, 0.033, 0.105)$

$BR = (-0.233, 0.5, -0.011)$

$GR = (0.417, 0.467, -0.433)$

$wq = (0.063, -0.023, -0.013)$

$BG \times wq = (0.002, -0.002, 0.013) \rightarrow$ Not a point within the x-y space.

$GR \times wq = (-0.016, -0.022, -0.039) \rightarrow$ maximally saturated point $(0.208, 0.286)$

$BR \times wq = (-0.007, -0.004, -0.026) \rightarrow$ maximally saturated point $(0.189, 0.108)$

QUESTIONS 6: **Type: MCQ**

Consider that the color of a source illuminant is represented by an RGB vector (150, 200, 100), whereas the target color is given by (150, 200, 200). Given a color vector (100, 200, 100) in the source image, compute the color corrected vector using diagonal correction rule.

a) (80, 160, 80)

b) (80, 160, 160)

c) (100, 200, 200)

d) (60, 120, 60)

Correct Answer: b)

Detailed Solution:

$k_r = \frac{R_d}{R_s} = 1, \quad k_g = \frac{G_d}{G_s} = 1, \quad k_b = \frac{B_d}{B_s} = 2$

where, R_d represent the R value of the target color vector and R_s represent the R value of the source color vector.

$f = \frac{R+G+B}{k_r R+k_g G+k_b B} = 0.8$

$R_u = f k_r R, \quad G_u = f k_g G, \quad B_u = f k_b B$

FOR QUESTIONS 7 AND 8:
Given Bayer's pattern.

$$\text{Bayer's Pattern} = \begin{bmatrix} G_1 & R_2 & G_3 & R_4 & G_5 \\ B_6 & G_7 & B_8 & G_9 & B_10 \\ G_{11} & R_{12} & G_{13} & R_{14} & G_{15} \\ B_{16} & G_{17} & B_{18} & G_{19} & B_{20} \\ G_{21} & R_{22} & G_{23} & R_{24} & G_{25} \end{bmatrix}$$

$$\text{Corresponding CFA values} = \begin{bmatrix} 10 & 14 & 18 & 24 & 30 \\ 15 & 25 & 35 & 45 & 55 \\ 24 & 45 & 150 & 225 & 168 \\ 65 & 87 & 124 & 100 & 144 \\ 34 & 225 & 200 & 235 & 245 \end{bmatrix}$$

. Based on the given data solve the following questions 7 and 8:

QUESTION 7: **Type: Comprehensive**

Interpolate R_8 using billinear interpolation.

Correct Answer: 77

Detailed Solution:

$R_8 = \frac{R_2+R_4+R_{12}+R_{14}}{4}$

QUESTION 8: **Type: Comprehensive**

Using interpolation by averaging red and blue hues, compute B_{12}.

Correct Answer: 55

Detailed Solution:

$B_{12} = \frac{G_{12}}{4}(\frac{B_6}{G_6} + \frac{B_8}{G_8} + \frac{B_{16}}{G_{16}} + \frac{B_{18}}{G_{18}})$.

QUESTION 9: **Type: MCQ**

CIE chromaticity model define 3 standard primaries: X, Y, Z that can be added to form all visible colors. Consider a pixel p whose RGB component is $(100, 150, 90)$. Compute the corresponding point for pixel p in normalised x-y chromaticity space. Consider the transformation matrix as $\begin{bmatrix} 0.49 & 0.31 & 0.2 \\ 0.18 & 0.81 & 0.01 \\ 0 & 0.01 & 0.99 \end{bmatrix}$.

a) $(0.23, 0.61)$

b) $(0.33, 0.41)$

c) $(0.25, 0.54)$

d) $(0.15, 0.33)$

Correct Answer: b)

Detailed Solution:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.49 & 0.31 & 0.2 \\ 0.18 & 0.81 & 0.01 \\ 0 & 0.01 & 0.99 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}.$$

Normalised $x = \frac{X}{X+Y+Z}$

Normalised $y = \frac{Y}{X+Y+Z}$

QUESTION 10: **Type:Numeric**

Interpolate G_5 using laplacian corrected edge correlated interpolation using given Bayer's pattern.

$$\text{Bayer's Pattern} = \begin{bmatrix} & & B_1 & & \\ & & G_2 & & \\ B_3 & G_4 & B_5 & G_6 & B_7 \\ & & G_8 & & \\ & & B_9 & & \end{bmatrix}$$

$$\text{Corresponding CFA values} = \begin{bmatrix} & & 15 & & \\ & & 25 & & \\ 160 & 65 & 100 & 125 & 180 \\ & & 65 & & \\ & & 25 & & \end{bmatrix}$$

Correct Answer: 75

Detailed Solution:

$\Delta H = |G_4 - G_6| + |B_5 - B_3 + B_5 - B_7| = 200$

$\Delta V = |G_2 - G_8| + |B_5 - B_1 + B_5 - B_9| = 200$

As $\Delta H < \Delta V$

$G_5 = \frac{G_2+G_4+G_6+G_8}{4} + \frac{B_5-B_1+B_5-B_3+B_5-B_7+B_5-B_9}{8} = 75$
