



Digital Image Processing (EE60062)

Mid-Semester Examination

Autumn, 2015-16

Credits: 4

Full Marks: 70

Duration of Examination: 2 hours

Date: 14 September 2015, Monday Time: 2:00 PM - 4:00 PM

Instructions:

1. All questions are compulsory. Marks are indicated in parentheses. This question paper has been cross checked and no errors exist.
2. Please write your name, roll number, subject name and code, date and time of examination on the answer script before attempting any solution.
3. Use of only electronic calculators is permitted.
4. No extra resources viz. graph papers, log-tables, trigonometric tables would be required.

Question 1:

An image sensor with 1600×900 elements is used to record a digital image in grayscale intensity format. The analog-to-digital convertor (ADC) attached to the sensor has a 14 bit resolution. The image can be stored in a file which allows byte mode read/write capability. What would be the size of the portable pixel map (ppm) in bytes used to store a full fidelity image recorded with this sensor? (5 marks)

Question 2:

- (a) Define the adjacency neighborhood relationship between the 0-marked pixels in these images? (4 marks)

$$I_1 = \begin{bmatrix} 1 & 1 & 1 & \underline{0} \\ 1 & 1 & 0 & 1 \\ 1 & 0 & 0 & 1 \\ 1 & \underline{0} & 1 & 1 \end{bmatrix} \quad I_2 = \begin{bmatrix} 1 & 1 & 0 & \underline{0} \\ 1 & 1 & 0 & 1 \\ 1 & 0 & 0 & 1 \\ 1 & \underline{0} & 1 & 1 \end{bmatrix}$$

- (b) What is the length of path traversal between the underlined pixels in these images as measured using (i) Euclidean distance, (ii) city-block (Manhattan) distance measures? (6 marks)

Question 3:

- (a) What is the maximum number of bits needed to store the following image? (1 mark)

$$I_3 = \begin{bmatrix} (4,4,4) & (4,4,4) & (0,0,0) & (6,6,6) \\ (2,2,2) & (2,2,2) & (2,2,2) & (0,0,0) \\ (2,2,2) & (4,4,4) & (4,4,4) & (7,7,7) \\ (1,1,1) & (3,3,3) & (0,0,7) & (0,7,0) \end{bmatrix}$$

- (b) Convert I_3 represented in the RGB format to (i) CYM and (ii) CYMK formats. (4 marks)

Question 4:

- (a) Compute the histogram of intensity of I_3 ? (2 marks)
- (b) Compute the pdf of intensity of I_3 ? (2 marks)
- (c) Find the maxima and minima locations on the pdf of intensity of I_3 ? (6 marks)

Question 5:

The zero-frequency component of the DFT of an 1000×1000 size image is 127.89×10^6 . Find the mean intensity of the image? Derive the solution with the steps involved in the process. (5 marks)

Question 6:

An image F is to be transformed to an image G . Deduce the value of $G(2,3) = F(2.5,4.5) = ?$ given that the transformation follows the bilinear interpolation rule and $F(2,4) = 20$, $F(2,5) = 0$, $F(3,4) = 20$, $F(3,5) = 20$. Provide detailed steps. (10 marks)

Question 7:

Match the histogram of intensity of I_3 to that of the histogram of the red-channel of I_3 ? Provide details of the steps involved and mention the image matrix after matching. (10 marks)

Question 8:

Prove that convolution of an image with an averaging kernel yields the low pass filtered version of the image. Mention all assumptions and conditions. (5 marks)

Question 9:

- (a) Derive an analytical expression for the Laplacian-of-Gaussian (LoG) kernel of any arbitrary size defined with σ as the isotropic standard deviation of the 2-D Gaussian kernel. (5 marks)
- (b) Derive the filtered response at the underlined pixel in the following image filtered using the homogeneous mask area filter? (5 marks)

1	1	1	2	3
1	1	1	3	4
2	1	<u>1</u>	5	6
3	5	6	9	1
4	7	8	0	0