Department of Electrical Engineering
Indian Institute of Technology Kharagpur

Digital Image Processing (EE60062)

End-Semester Examination **Autumn, 2015-16**

Credits: 4 Full Marks: 100 Duration of Examination: 3 hours
Date: Time:

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. Polar graph sheet, provided with the question paper for response to Q6, is to be attached to answer script.

Question 1:

The output from two image sensors are stored in a variable length image file (VLIF) format with a 120 byte header. The first sensor with 800 × 600 elements is used to record a digital image in 14-bit grayscale intensity format with a header of 40 bits. The second sensor has 8-bit per plane RGB 400 × 300 elements and header of 8 bytes. What is the size of the file used to store together single frames from both the sensors? (5 marks)

Question 2:

Consider the following RGB color image and answer the following questions

$$I_1 = \begin{bmatrix} (4,4,4) & (4,4,4) & (0,0,0) & (6,6,6) \\ (2,2,2) & (2,2,2) & (2,2,2) & (0,0,0) \\ (2,2,2) & (4,4,4) & (4,4,4) & (7,7,7) \\ (1,1,1) & (3,3,3) & (0,0,7) & (0,7,0) \end{bmatrix}$$

(a) Convert I_1 and represent it in CYM and CYMK formats? (2+2 mark)

(b) Compute the histogram of I_1 and the intensity of I_1? (2+2 mark)

(c) Compute the entropy of I_1 and the intensity of I_1? (2+2 mark)

(d) Compute the DFT of the intensity of I_1? (5 marks)

(e) Mark the pixels which are closest Euclidean distance neighbours of color (1,2,3)? (3 marks)

Question 3:

An image $\{f(x,y)\} \in F$ is transformed to an image $\{g(x,y)\} \in G$ using the transformation $g(x,y) = -f(x-1,y-1) + f(x+1,y+1) - f(x,y) + f(x+1,y) + f(x+1,y+1)$ with (x,y) increasing left→right and top→bottom respectively. Write down the convolution and correlation kernels for implementing this operation? (2.5+2.5 marks)

Question 4:

White balance the image I_1 using either the white patch or gray world approximation? (5 marks)

Question 5:

Consider the following image I_2 and derive the following

1	1	1	2	3
1	1	1	3	4
2	1	1	5	6
3	5	6	9	1
4	7	8	0	0

(a) Response of homogeneous mask area filter at the underlined pixel? (3 marks)

(b) The unit radius 8 neighbour rotationally invariant local binary pattern (LBP) at the underlined pixel? (3 marks)

(c) The co-occurrence matrix of the image I_2 using a 1 pixel 45° NW pointing vector unidirectional relationship? (3 marks)

(d) Compute the entropy of the co-occurrence matrix computed above? (2 marks)

(e) Using iterative threshold selection scheme derive the intensity level which can be used for segmenting the image I_2 into two classes? (4 marks)

Question 6:

(a) Derive the directional amplitude response of the following kernels and plot them? (8 marks)

$$h_1 = \begin{bmatrix} 0 & -1 & 0 \\ 0 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} \quad h_2 = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

(b) Which kernel is best suited as an iso-directive gradient estimator? (2 marks)

Question 7:

Let $i \in [0, L-1] \supset \mathbb{Z}$ be the intensity value in a grayscale image G with $h(i)$ its histogram and $p(i)$ its pdf such that $p(i) = h(i) \Big/ \sum_{i=0}^{L-1} h(i)$. Let the problem we now deal with, be of partitioning the pdf at an intensity level k, such that the intensity values $[0,k]$ belong to Class 1 with prior probability $P_1(k)$, and intensity values in the range $[k+1, L-1]$ belong to Class 2 with prior probability $P_2(k)$. In this scenario, we also assume $\mu_1(k)$ to be the mean of Class 1 and $\mu_2(k)$ to be the mean of Class 2 and μ_G to be the global mean of G computed using the pdf. Also we define another term as $\mu(k) = \sum_{i=0}^{k} ip(i)$. If we define a new term as the between class variance

$$\sigma_B^2(k) = P_1(k)(\mu_1(k) - \mu_G)^2 + P_2(k)(\mu_2(k) - \mu_G)^2 \quad \text{(Eq. 1)}$$

$$\sigma_B^2(k) = \frac{(P_1(k)\mu_G - \mu(k))^2}{P_1(k)(1 - P_1(k))} \quad \text{(Eq. 2)}$$

Then prove that Eq. 2 can be derived from Eq. 1. Please provide detailed explanation and deduction of all the stages involved in the process. (15 marks)

Question 8:

Deduce the response of graylevel (a) erosion, (b) dilation, (c) opening, (d) closing and (e) top-hat transform over all pixels in I_2 using an isotropic 3 × 3 square structuring element? (10 marks)

Question 9:

Compute and plot the (a) polar form shape signature and (b) its Fourier descriptor for the contour represented by the following Chain Code {N, N, NE, NE, SE, SE, S, S, W, W, W, W}? (5+10 mark)

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Polar graph sheet for response to Question 6 (a).

Please detach this sheet and attach it with your answer script.