Indian Institute of Engineering Science and Technology, Shibpur

M.E. (ETC) 2nd Semester Final Examination, 2014

Digital Image Processing & Computer Vision (ETC-1015)

Full Marks: 70 **Time: 3 hours**

Attempt any five questions from the following
Answer should be brief and to the point
Unnecessary lengthy answer may result in loss of marks

1. Following small image (A) has grey values in the range 0 to19. Compute the grey level histogram and the mapping that will equalize the histogram. Produce an 8 X 8 grid containing the grey values for the new histogram-equalized image.

$$A = \begin{bmatrix} 12 & 6 & 5 & 13 & 14 & 14 & 16 & 15 \\ 11 & 10 & 8 & 5 & 8 & 11 & 14 & 14 \\ 9 & 8 & 3 & 4 & 7 & 12 & 18 & 19 \\ 10 & 7 & 4 & 2 & 10 & 12 & 13 & 17 \\ 16 & 9 & 13 & 13 & 16 & 19 & 19 & 17 \\ 12 & 10 & 14 & 15 & 18 & 18 & 16 & 14 \\ 11 & 8 & 10 & 12 & 14 & 13 & 14 & 15 \\ 8 & 6 & 3 & 7 & 9 & 11 & 12 & 12 \end{bmatrix}$$

How can histogram be useful in object segmentation?

10+4

2. What do you understand by spatial filtering? Define linear and non-linear spatial filters with suitable examples. Devise a 5 x 5 mask for an identity filter which causes no change in the image. Consider the 6 x 6 noise-corrupted digital image (B). Extract the inner 4 x 4 image matrix from it using the outlier method by choosing a suitable threshold value.

$$B = \begin{bmatrix} 1 & 1 & 2 & 5 & 3 & 1 \\ 3 & 20 & 5 & 6 & 4 & 6 \\ 4 & 6 & 4 & 20 & 2 & 2 \\ 4 & 3 & 3 & 5 & 1 & 5 \\ 6 & 5 & 20 & 2 & 20 & 2 \\ 6 & 3 & 1 & 4 & 1 & 2 \end{bmatrix}$$

2+3+2+7

3. Sate and prove the 'separability' property of two-dimensional Fourier transform. Find out the number of complex multiplications required to convolve a 512 X 512 image with a 16 X 16 filter using direct method and FFT algorithm respectively. Hence calculate the speed up. Explain the impact of mask size on the overall blurring by analyzing the characteristic of averaging filter in the transformed domain.

4+6+4

4. Find out the mask coefficients of discrete Laplacian filter for detecting edges in an image. Hence apply it for detecting edges from the image C.

$$C = \begin{bmatrix} 50 & 50 & 50 & 50 & 50 & 50 & 50 & 50 & 50 & 50 \\ 50 & 50 & 50 & 50 & 50 & 50 & 50 & 50 & 50 & 50 \\ 50 & 50 & 200 & 200 & 200 & 200 & 200 & 200 & 50 & 50 \\ 50 & 50 & 200 & 200 & 200 & 200 & 200 & 200 & 50 & 50 \\ 50 & 50 & 200 & 200 & 200 & 200 & 200 & 200 & 50 & 50 \\ 50 & 50 & 200 & 200 & 200 & 200 & 200 & 200 & 50 & 50 \\ 50 & 50 & 50 & 50 & 200 & 200 & 200 & 200 & 50 & 50 \\ 50 & 50 & 50 & 50 & 200 & 200 & 200 & 200 & 50 & 50 \\ 50 & 50 & 50 & 50 & 50 & 50 & 50 & 50 & 50 & 50 \\ 50 & 50 & 50 & 50 & 50 & 50 & 50 & 50 & 50 & 50 \end{bmatrix}$$

4+10

5. What do you mean by 'unsharp masking'? Find out the coefficients of unsharp masking filter. Show that for an image A and kernel B; $\overline{A \ominus B} = \bar{A} \oplus \hat{B}$; where the symbols enjoy their usual significances. Mention few applications of dilation and erosion. How can internal and external boundary be detected?

2+2+6+2+2

6. Detect the strongest line in the binary image (D) shown below. Use the form $x\cos\theta + y\sin\theta = r$, $-3 \le x \le 3$ *and* $-3 \le y \le 3$ with θ in steps of 45° from -45° to 90° and place the result in an accumulator array.

$$D = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

For the image E, apply the distance transform to find out the approximate distance from the region containing 1's to all other pixels in the image using any suitable mask.

$$E = \begin{bmatrix} 0 & 0 & 0 & 1 & 0 & 0 \\ 1 & 1 & 1 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \end{bmatrix}$$

10+4

7. Determine the saturation and intensity components of the following 3-bit image (F), where the RGB values are as given:

$$F = \begin{bmatrix} (0,1,1) & (1,2,3) & (7,7,7) \\ (2,1,2) & (1,7,7) & (2,0,2) \\ (4,4,4) & (4,6,7) & (4,5,6) \end{bmatrix}$$

Using run length encoding, encode the following 4-bit image (G):

$$G = \begin{bmatrix} 1 & 1 & 3 & 3 & 1 & 1 \\ 1 & 7 & 10 & 10 & 7 & 1 \\ 6 & 13 & 15 & 15 & 13 & 6 \\ 6 & 13 & 15 & 15 & 13 & 6 \\ 1 & 7 & 10 & 10 & 7 & 1 \\ 1 & 1 & 3 & 3 & 1 & 1 \end{bmatrix}$$

7+7

8. What do you mean by production system? What are the limitations of classical production system? Narrate Generalized Hypothetical Syllogism (GHS). Consider the following fuzzy production rules and the membership distribution functions:
PR$_1$: IF age is YOUNG THEN speed is HIGH
PR$_2$: IF speed is HIGH THEN blood-pressure is LARGE

$$\mu_{YOUNG}(age) = \{\frac{0.3}{5\ yrs}, \frac{0.4}{10\ yrs}, \frac{0.5}{15\ yrs}, \frac{0.7}{20\ yrs}, \frac{0.9}{25\ yrs}\}$$

$$\mu_{HIGH}(speed) = \{\frac{0.3}{2\ kmp\ h}, \frac{0.5}{5\ kmp\ h}, \frac{0.8}{8\ kmp\ h}, \frac{0.9}{10\ kmp\ h}\}$$

$$\mu_{LARGE}(blood-pressure) = \{\frac{0.4}{80\ mmHg}, \frac{0.6}{110\ mmHg}, \frac{0.8}{140 mmHg}, \frac{0.9}{170\ mmHg}\}$$

$$\mu_{MORE-OR-LESS\ YOUNG}(age) = \{\frac{0.35}{5\ yrs}, \frac{0.45}{10\ yrs}, \frac{0.55}{15\ yrs}, \frac{0.75}{20\ yrs}, \frac{0.95}{25\ yrs}\}$$

Find out the membership distribution function $\mu_{MORE-OR-LESS\ LARGE}(blood-pressure$ using GHS.

2+2+3+7

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