INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, ALLAHABAD

Mid-Semester Examination: February 2018

Date of Examination (Meeting) : 22.02.2012 (IInd Meeting)

Program Code & Semester : B.Tech.(IT), Dual degree B.Tech-M.Tech. - 6th Sem.

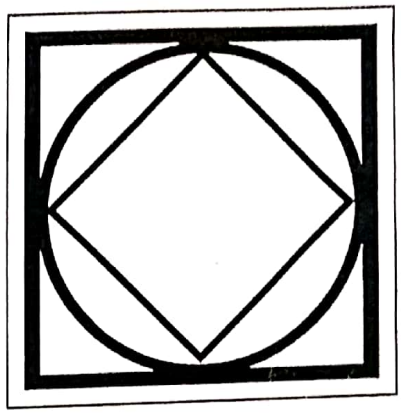
Paper Title: Image and Video Processing

Paper Code: IIVP 632C

Paper Setter: Dr. Pavan Chakraborty and Dr. S. K. Singh

Max Marks: 30 **Duration: 2 hours**

Note: Simple Scientific Calculator allowed,
Answers should be brief and to the point.
Unnecessary Extra writing will attract negative marks.



1. The Binary image as shown in the figure is of 2001X2001 pixel. The outer square in the image has a side of 1750 pixels and is centered on the image. The circle is tangent to the outer square on all 4 sides. The inner square is rotated by 45° and its four corners touch the outer square.
   This Binary image is transformed to an $r - \theta$ image around the center (1001,1001). The horizontal axis of the transformed image is r, while the vertical axis is θ were each pixel corresponds to 0.5°.
   a) Write pseudo code to make this transformation. The output (r x θ) will be (2000x1000) pixel. The pixels of the output image are made black where the output image overshoots the input image. Denote the input image pixel indices by (i , j); while the output image indices be denoted by (l , k). Choose on which 2 indices will the "for" loops be performed so that the output image is complete.
   b) Draw the output image and mark the pixels. **[(2+1)+2=5]**

2. If we define the x-y coordinates of an image along the column i and row j, of the image, we can obtain the derivative image along the x-axis as shifting the image in column i and subtracting it from the original image.
   a) How will you obtain the derivative image along y-axis.
   b) Now if the x-y coordinates of the image is not aligned with the column i and row j but is defined by $x = a.i + b.j + c$ $y = d.i + e.j + f$

   How will you now obtain the derivative image in x and in y.
   c) A particular image has a circular similarity around a point x_0 and y_0. Now to check the radial and angular aberrations, we need to perform radial and angular derivatives of the image. Describe the method of performing the derivative image in r and θ **[1+2+2=5]**

3. Explain histogram equalization? What are the constraints taken for the transfer function and explain the reason of those constraints? **[5]**

Date of Submission: Feb 27, 2016 **Faculty Signature** _____

4. (a) For a given *pdf* $P_r(r)$, find out the histogram equalization transformation function and corresponding *pdf*.

$$P_r(r) = \begin{cases} \frac{5r^3}{(L-1)^3} & 0 \ll r \ll L-1 \\ \cdot & \cdot \\ 0 & Otherwise \end{cases}$$

(b) Again the histogram equalization has been applied on the obtained equalized histogram as in 4(a). Find out the resultant histogram.

[3+2=5]

5. Explain histogram matching? Suppose for a 3 bit image, the intensity distribution is as follows,

0	1	2	3	4	5	6	7
5	8	7	5	9	18	23	17

We want an image such that the pixel-count in the image follows the equation

$$n_k = -(r_k - 4)^2 + 17$$

where r_k is the kth intensity value and n_k is the number of pixels having intensity r_k.
Draw the histogram for given image, desired image and equalized images. Find the histogram transformation function.

[3+2=5]

6. Prove that the following two step process on a given image $I(x,y)$ as shown in Scheme-1 is equivalent to the process shown in Scheme-2,

Scheme-1

a. Smoothen the image $I(x,y)$ with Gaussian, $G(x,y) = \frac{1}{\sqrt{2\pi\sigma^2}} exp\left(-\frac{x^2+y^2}{2\sigma^2}\right)$

b. Take the Laplacian of the Image as obtained in step (a)

Scheme-2

a. Take the Laplacian of Gaussian, $G(x,y) = \frac{1}{\sqrt{2\pi\sigma^2}} exp\left(-\frac{x^2+y^2}{2\sigma^2}\right)$

b. Convolve the result obtained in step (a) with image $I(x,y)$

Hint: $\frac{d}{dt}[h(t) * f(t)] = f(t) * \frac{d}{dt}h(t)$

If both the schemes are equivalent then which scheme should be preferred with the point of view of computational load?

[4+1=5]