Computer Engineering Department, S V N I T, Surat
Mid Semester Examination, November 2020
M.Tech.-I Computer Engineering (First Semester)
Course: (CO611) Computer Vision and Image Processing

Date: 3 Nov 2020 Time: 11:30 am to 1:00 pm Marks: 30

Instructions:
1. Write your MTech Admission No/Roll No and other details clearly on the answer books.
2. Assume any necessary data but give proper justifications.
3. Be precise and clear in answering the questions.
4. Write your Admission No. on every page at left top corner and page number at bottom right corner of each page.
5. Scan all pages in sequence and create a PDF file for submission.

Q.1

(a) Write a 2D DFT formula and present the same in matrix form. That is, DFT of an image, $F(u,v) = U^T f U$ where f is an input image $f(x,y)$ of size $N \times N$ and U symmetric matrix. Assume $N = 4$. [3]

(b) Compute real and imaginary part of DFT of an image $g = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$ [3]

Q.2 Show that the Laplacian operation is isotropic (invariant to rotation). The following are the equations relating coordinates after axis rotation by an angle θ: [6]

$$\begin{aligned} x &= x' \cos\theta - y' \sin\theta \\ y &= x' \sin\theta - y' \cos\theta \end{aligned}$$

where (x, y) are the unrotated and (x', y') are the rotated coordinators.

Q.3

(a) Show that if $f(x,y)$ is an $M \times N$ image defined as a periodic function with period N and M in whole (x,y) space, its DFT $F(u,v)$ is also periodic in (u,v) space with same periods. That is, show that $F(u+M, v+N) = F(u,v)$. [3]

(b) What is histogram equalization? Why does histogram equalization usually not produce images with flat histograms? [3]

Q.4 The histogram of an image can be approximated by probability distribution function $p_r(r) = Ae^{-r}$. A is normalizing factor and intensity r varies 0 to l. Calculate transformation function $s = T(r)$ such that $p_s(s) = Bse^{-s^2}$. B is normalizing factor and intensity s takes value between 0 to l. (Hint: $p_s(s)ds = p_r(r)dr$) [6]

Q.5 What happens to DFT of an image if image is (a) rotated (b) shifted (c) scaled? Illustrate through the required steps of derivation and necessary equations. [6]