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INDIAN INSTITUTE OF TECHNOLOGY JAMMU

NH44, Nagrota, Jagti, Jammu-181221

Programme Name: PhD
Comprehensive Examination, Dec-2024

Course Name: Digital Image Processing
Date: 12/12/2024   **Time:**
Duration:2.5 Hours   **Max. Marks: 50**

Note:

- All the questions are compulsory. You are free to make any assumption by clearly stating the conditions
- Please mention all the steps clearly

Q1. Show that the Laplacian operation is isotropic that to say are rotation invariant. Deduce a framework to show that the following equations relating coordinates after axis rotation by an angle θ.

$$x = x' \cos\theta - y' \sin\theta$$
$$y = x' \sin\theta + y' \cos\theta$$

Where *(x, y)* are unrotated and *(x, y)* are the rotated coordinates.   (9)

Q2. Consider a spatial mask that averages the four closest neighbors of a point (x, y), but excludes the point itself from the average.
(a) Write an expression of filter in spatial domain Find the equivalent filter, H(u,v) in the frequency domain.
(b) Show that your result is a lowpass filter.   (10)

Q3. Consider the following image, in which the squares are fully saturated red, green, and blue, and each of the colors is at maximum intensity [e.g., (1, 0, 0) for the red square]. An HSI image is generated from this image.
(a) Describe the appearance of each HSI component image.
(b) The saturation component of the HSI image is smoothed using an averaging mask of size Describe the appearance of the result (you may ignore image border effects in the filtering operation).
(c) Repeat (b) for the hue image.   (10)

Q4. Show that the saturation component of the complement of a color image cannot be computed from the saturation component of the input image alone. (6)

Q5. Refer to the contraharmonic filter
(a) Explain why the filter is effective in elimination pepper noise when Q is positive.
(b) Explain why the filter is effective in eliminating salt noise when Q is negative.
(c) Explain why the filter gives poor results when the wrong polarity is chosen for Q.
(d) Discuss the behavior of the filter when $Q=-1$
(e) Discuss (for positive and negative Q) the behavior of the filter in areas of constant intensity levels. (5)

Q6. You may assume in both of the following cases that the threshold value during iteration is bounded in the open interval
(a) Prove that if the histogram of an image is uniform over all possible intensity levels, the basic global thresholding algorithm converges to the average intensity of the image,
(b) Prove that if the histogram of an image is bimodal, with identical modes that are symmetric about their means, then the basic global algorithm will converge to the point halfway between the means of the modes (10)

Green	Red
Blue	Green

*****Best of Luck*****