UNIVERSITY OF CALGARY
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
SCHULICH SCHOOL OF ENGINEERING
ENEL697 DIGITAL IMAGE PROCESSING
TEST NO. 1
WINTER 2013 SESSION
27 February 2013

Instructions:

1. This is a closed-book, closed-notes test.
2. Calculators and other electronic devices are not permitted.
3. Answer all five questions.
4. Show all steps in your derivations or calculations of results.
5. Total marks = 20.
6. Time permitted = 75 minutes.

Question 1: Give an equation to define the discrete Fourier transform of an $M \times N$ digital image.

Explain the properties of separability and symmetry of the Fourier transform kernel.

With mathematical expressions as required, explain how the two-dimensional Fourier transform may be evaluated as a series of one-dimensional Fourier transforms.

(4 marks)

Question 2: Give the equation to define the entropy of a digital image with L gray levels. Explain how entropy may be estimated from the histogram of the image.

Define the joint entropy of two images f and g. Explain the meaning of the function(s) you use to define joint entropy. Explain how joint entropy is related to the individual entropies of the images and state any conditions that may apply.

(4 marks)

Question 3: You are given the following digital image:

$$f(m,n) = \begin{bmatrix} 1 & 2 & 1 & 2 & 4 \\ 3 & 5 & 4 & 3 & 4 \\ 5 & 6 & 7 & 2 & 5 \\ 3 & 2 & 1 & 3 & 1 \\ 2 & 5 & 3 & 4 & 2 \end{bmatrix}. \tag{1}$$

For the two pixels with the values of 6 and 7 in the input image, compute the outputs of the following operators using a 3×3 neighborhood:

- the median,
- the $\alpha-$trimmed mean filter with $\alpha = 1/3$.

Show all steps in your calculations of the results.

(4 marks)

Question 4: Write the mathematical expressions for

- the signal-to-noise ratio,
- simultaneous contrast, and
- the contrast-to-noise ratio.

Explain how these measures are useful in image processing.

(4 marks)

Question 5: Describe the distinction between fixed filters and adaptive filters for noise removal. Using at least one detailed equation, explain the design of any one type of an adaptive filter to remove noise. Describe the parameters involved in the design and explain how adaptive filtering is achieved.

(4 marks)

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