

UNIVERSITY OF CALGARY  
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING  
ENEL697 DIGITAL IMAGE PROCESSING  
TEST NO. 2  
WINTER 2003 SESSION  
9 April 2003

**Instructions:**

1. This is a closed-book, closed-notes test.
2. The use of only a non-programmable calculator with no text storage facilities is permitted.
3. Answer all five questions.
4. Total marks = 20.
5. Time permitted = 90 minutes.

**Question 1:** A researcher processes an image by first applying the  $3 \times 3$  mean filter, and then applying the  $3 \times 3$  Laplacian operator.

Derive the impulse response of the complete operation.

Explain the effect of each filter and of the complete operation. (5 marks)

**Question 2:** You are given the test image

$$f(m, n) = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 10 & 10 & 10 & 0 \\ 0 & 10 & 10 & 10 & 0 \\ 0 & 10 & 10 & 10 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}.$$

Assume the image to be zero outside the given array.

Compute the result of application of the  $3 \times 3$  subtracting Laplacian operator.

Explain the effect of the operator on the image. (3 marks)

**Question 3:** Derive the frequency response (MTF) of the  $3 \times 3$  unsharp masking filter and explain its characteristics. (5 marks)

**Question 4:** A poorly exposed image was found to have gray levels limited to the range 45 – 110. Derive a linear transform to stretch this range to the full display range of 0 – 255.

Give the display values for original (input) gray levels of 55 and 80. Show all steps in your calculations. (3 marks)

**Question 5:** Write the expression for the autocorrelation function of an image, as computed from a given, single, digital image.

Using pseudocode format, give the procedure to compute the autocorrelation function. Show all the necessary programming steps and details.

Explain how you handle the size and indices of the given image and the result.

Explain what the indices represent in the output.

(4 marks)

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