

McMaster University
Department of Electrical and Computer Engineering
CoE4TN3 Image Processing
Midterm Exam, February 26, 2004

Exam duration: 50 minutes

Name:

Student Number:

Problem 1. (20 points) Given an image of size $M \times N$, you are asked to perform an experiment that consists of repeatedly lowpass filtering the image using a Butterworth lowpass filter with a given cutoff D_0 . You may ignore computational round-off errors. Let k_{\min} denote the smallest positive number representable in the machine in which the proposed experiment will be conducted.

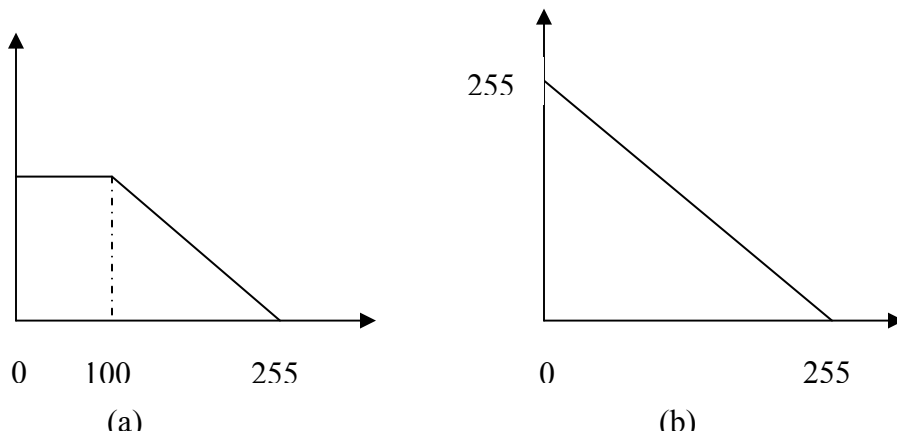
- (a) (10 points) Let L denote the number of applications of the filter. Can you predict what the result image will be for a sufficiently large value of L ? If so what is that result?
- (b) (10 points) Derive an expression for the minimum value of L that will guarantee the result that you predict

Hint: Assume that numbers less than $0.5k_{\min}$ are rounded to zero. The form of a lowpass

Butterworth filter with a cutoff frequency of D_0 is $H(u, v) = \frac{1}{1 + [D(u, v) / D_0]^{2n}}$ and

$$D^2(u, v) = u^2 + v^2$$

Problem 2. (10 points) An image with the histogram shown in (a) is subjected to the gray level transformation shown in (b). What the histogram of the output image is going to be?



Problem 3. (10 points) Combining high-frequency emphasis and histogram equalization is an effective method for achieving edge sharpening and contrast enhancement.

- a) Does it matter which process is applied first?
- b) If the order does matter, give a rationale for using one or the other method first.

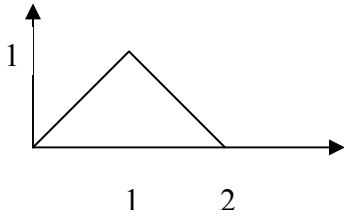
Problem 4.

- (a) (5 points) Explain why harmonic mean filter is not effective in eliminating pepper noise.
- (b) (5 points) For what type of noise is alpha-trimmed filter effective?
- (c) (5 points) Briefly explain how color imaging is done in CCD imaging systems.
- (d) (5 points) What is photopic?

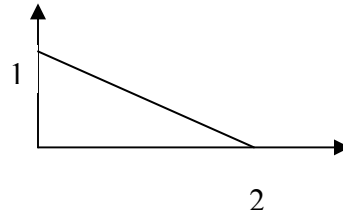
Problem 5. (10 points) Consider the image segment shown. Let $V=\{0,1\}$ and compute the lengths of the shortest 4-, 8- and m-path between p and q. If a particular path does not exist between these two points explain why.

	3	1	3	2	
	1	1	0	1	
	0	2	3	0	q
p	1	0	1	2	

Problem 6. (20 points) The histogram of an image can be approximated by the probability density function shown in (a). Calculate the transformation $s=T(r)$ where s is the grey level in the transformed image, such that the transformed image has probability density function shown in (b).



(a)



(b)

Problem 7. (10 points) An image processing operation in the space domain consists of calculating the $f(x,y+1)+f(x+1,y)-2f(x,y)$.

1. Obtain the filter transfer function, $H(u,v)$ for performing the equivalent process in the frequency domain.
2. Is $H(u,v)$ a high pass or low pass filter?