EE 569: Introduction to Digital Image Processing

Midterm Exam

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Location:	OHE STD. A
Date:	Nov.6, 1998
Start time:	9:00 A.M.
Stop time:	11:00 A.M.

Name: ————————————————————-

Show all work on exam papers.
Print your name and ID number on all sheets.

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Problem 1: (20 points) Image Enhancement and Histogram Equalization
Assume that we have an image of 8×8 pixels as shown below:

0	1	1	1	1	1	1	1
0	1	1	1	2	2	2	2
0	0	2	2	2	2	2	2
0	0	3	3	3	3	3	3
0	0	3	3	3	5	5	6
0	5	5	5	5	5	5	6
0	6	6	6	6	6	6	6
0	7	7	7	7	7	7	7

which is displayed on a 16 gray-level device.

- (a) (5 points) To enhance the image, we want to stretch the intensity of this image to the full dynamic range. Design a linear transform to achieve this objective. Give the transformation function.
- (b) (5 points) What is the histogram of the output image after your transformation?
- (c) (5 points) We want to modify the gray scale of this image such that the histogram of the processed image as close as possible to being constant. How to perform the equalization? Determine the transformation for the historgram equalization without randomization.
- (d) (5 points) Can you achieve the objective by using the method in (c)? If yes, what is the histogram of your output image? If no, what kind of method can you use? Describe your new transformation.

Problem 2: (20 points) Geometric Transformation

- (a) (5 points) Let $A(221, 396) = 18$, $A(221, 397) = 45$, $A(222, 396) = 52$, and $A(222, 397) = 36$. What is $A(221.3, 396.7)$ obtained by bilinear interpolation?
- (b) (15 points): An original image of size 256×256 is manipulated by the following operations:

  1.Rotate by 30 degrees counter clockwise about pixel (row,column)=(240,10) 2.magnify by 37% larger than the original. 3.Shift the obtained image such that the output image are bounded by the top and left boundary of the original image.

  Give the transform matrix for each step respectively, and the combined matrix of three operations. Describe your method to get the output image in detail.

Problem 3: (20 points) Digital Halftoning
An original image of size 128×128 is a gray-level image with 8 bits per pixel. It is halftoned into a binary image for imprinting. To keep a good visual quality, the halftoned binary image should has higher resolution than theoriginal gray-level image. If we want to get a binary image of size 1024×1024 pixels,

- (a) (5 points) Design a method to do the halftoning such that the resulting binary image has good quality.
- (b) (5 points) Consider the implementation of your designed method under low-memory situation.What kind of method can you use to reduce the necessary memory without increasing the computation complexity too much?
- (c) (5 points) Will your scheme proposed in (b) cause any new artifacts to the resulting binary image? If yes, what is the artifacts could be? and how to resolve it?
- (d) (5 points) Assume the memory for the original image and the resulting binary image can not be used for your computation, estimate the extra memory needed for your implementation.

Problem 4: (20 points) Binary Image Classification
Considering the following binary image. We want to seperate each symbol by binary image analysis and feature extraction. Design an algorithm and describe it in a structural way.

Problem 5: (20 points) Morphological Processing
Given the following binary image patterns, what are the stable results after

- thinning
- shrinking
- skeletoning