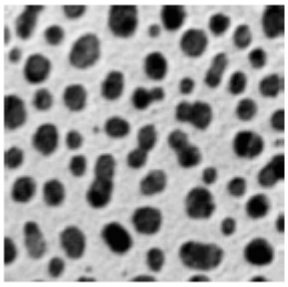
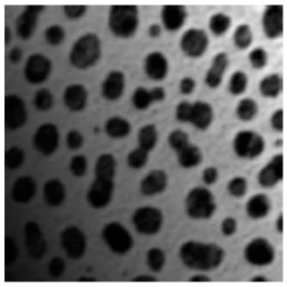
1) Suppose that an image of dimensions 4×6 inches has detail to the frequency of 300 dots per inch in each direction.
   a) How many samples are required to preserve the information in the image?
   b) How many values are contained in the DFT of the image?
   c) Suppose that the image is sampled at a frequency that corresponds to detail up to 600 dots per inch (but in reality the detail only goes to 300 dots per inch). What is the effect on the DFT?

2) The images blobz1.png and blobz2.png are shown in below. The difference is that blobz1 has nearly uniform illumination while blobz2 has very nonuniform illumination.


blobz1.png


blobz2.png

   a) Construct an algorithm that will segment the blobz1.png image. This algorithm can use a global threshold that can be chosen by examination of the image histogram.
   b) Construct an algorithm that will segment the blobz2.png image.

3) A binary array that represents a portion of a black and white image is given below. Perform the operations listed below on this piece of image. Assume that all of the pixels that surround this segment contain black background.

0 0 0 0 0 0 0
0 0 1 1 0 0 0
0 0 0 1 0 0 0
0 0 0 1 1 0 0
0 0 1 1 1 1 0
0 0 1 1 1 0 0
0 1 0 1 0 1 0
0 0 0 0 0 0 0

   a) Dilation with the structuring element 1 1 1
   b) Erosion with the structuring element 1 1 1
   c) Dilation with the structuring element

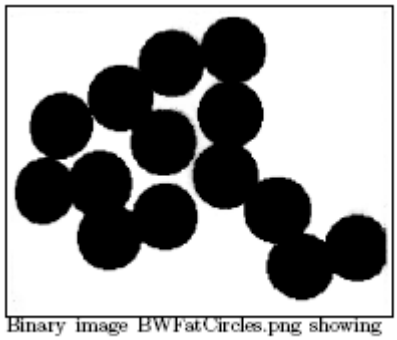
1 1
0 1

   d) Erosion with the structuring element

1 1
0 1

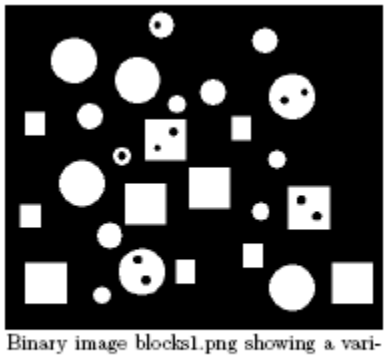
e) Opening with each of the above structuring elements.
f) Closing with each of the above structuring elements.

4) Shown below is an image with a number of touching black disks against a white background. Construct a program that will count the number of disks.



Binary image BWFatCircles.png showing a number of touching disks.

5) Shown below is an image with circles and squares of various sizes. Some of the objects have one or two holes in them. You are to provide an algorithm that uses morphological and logical operations to answer the questions below.



Binary image blocks1.png showing a variety of circles and squares, some of which have one or two holes.

a) What fraction of the image pixels are white?
b) How many objects are in the image?
c) How many holes are in the image?
d) How many objects have one or more holes?
e) How many square objects are in the image?
f) Identify the square objects that have holes.
g) Identify the circular objects that have no holes.

6) Consider the edge model depicted below. Sketch the gradient and Laplacian of the signal. It is not needed to compute exact numerical

values in your answer. Plot of approximate shapes of the responses will be sufficient.

7) Assume you are given an image that suffers from the following problems related to image quality.

a) The image does not have enough contrast. Most areas in the image appear to be too bright.

b) The structures and boundaries in the image are blurred and thus it is hard to see the details of objects in the image.

c) There are random sparse black spots (pepper noise) that seem to be caused by some electronics noises.

You are asked to propose a system that use techniques you have learned in this class to improve the overall image quality. Please design a conceptual diagram for a quality enhancement system that addresses all the problems mentioned above. Provide justifications for the use of each component and the specific order you adopt in combining different components. Try to provide as much information as needed. For example, if you use contrast stretching, specify the shape of the intensity mapping function. If you use sharpening filters, specify the specific type of filter you will use.

8) Consider a JPEG compression pipeline using 4x4 image blocks instead of 8x8. The coefficients you generate by doing a DCT on a 5x5 block of luminance values are given by

140	20	8	5
23	18	7	8
15	10	6	2
9	5	1	2

The quantization table you are given is

5	12	16	30
12	14	20	30
14	20	32	35
20	25	29	40

a) Generate the values of the image after quantization?

b) In what order will the quantized table transmitted?

c) How can you further compress the sequence?