

Name: _____

SIMG-782 Introduction to Digital Image Processing

Final Exam

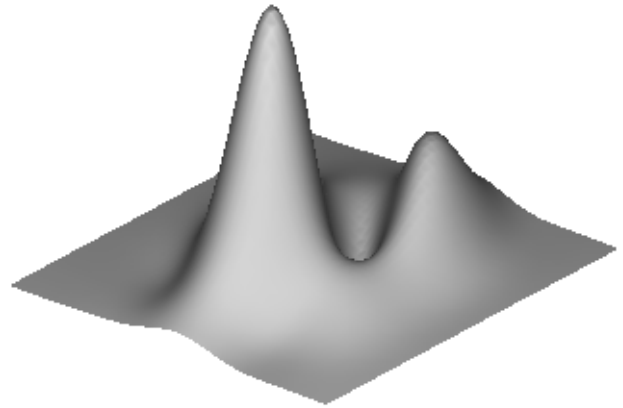
November 20, 2003

Closed book and notes. Work all problems. Clearly show your reasoning and identify the solution.

1. An image array $f(m, n)$ of size $M_1 \times N_1$ is to be convolved with a filter array $h(m, n)$ of size $M_2 \times N_2$ to produce a new image array $g(m, n)$.
 - (a) Write a pseudo code program that describes a method to compute $g(m, n)$ through the use of Fourier transforms. The result should be the same size as would be achieved with direct convolution.
 - (b) Modify the algorithm so that it does the correlation $f \circ h$ rather than the convolution.

2. An elevation map of a 1 km square area is shown in the figure. A geology student needs to compute the fraction of the rainfall that will collect in the depression between the hills and form a lake. As an image processing expert you believe that you have a way to compute the water runoff given the elevation data.

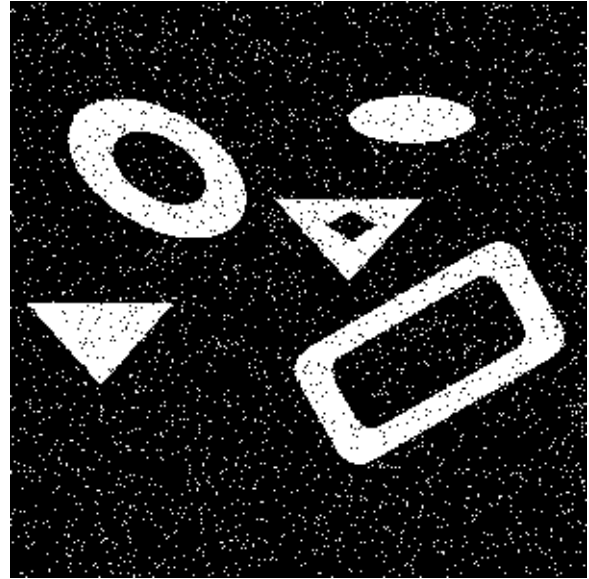
Describe an algorithm that can compute the water runoff from a general rainfall given the elevation map.



3. You have the job of designing an algorithm that will count the number of objects with holes and the number of objects without holes in images of the kind shown here. Assume that the images are binary with 0 corresponding to black and 1 corresponding to white. The imaging system is of low quality and produces images that are corrupted with salt and pepper noise.

The objects do not overlap or touch, but may be close to each other in any direction. They may be of any shape or size. The algorithm should not be confused by the salt and pepper noise, and should not count noise pixels as objects.

Write a pseudo-code description of your algorithm. You may also include a block diagram and other information to make it understandable to a programmer. State any assumptions you make, such as: "Objects must contain at least 50 pixels."



4. A telescope in an orbiting observatory is used to produce images on a high-resolution CCD array. It has been found that the images are a little blurry due to optical effects in the telescope. You have been called in as an image processing expert to devise a method to sharpen the digital images. Describe how you would go about solving the problem, given that the only images you can obtain are of astronomical objects. You cannot modify the telescope in any way. The only option is to process the digital images.

5. An imaging system has a spatially invariant impulse response function

$$h(x, y) = Ke^{-(x^2+y^2)}$$

Suppose that the input image $f(x, y)$ to the system is a vertical line located at $x = a$.

- (a) Construct an analytical model to compute the output $g(x, y)$ given the input $f(x, y)$.
- (b) Compute and sketch the output. Note: The calculation will have an unknown multiplicative scale factor.