Image Processing

HI 5323 Mid Term Exam

Date: Name:

Problem 1: Which of the following is *not* a range value of a signal?

X time
O graylevel
O ultrasound

Problem 2: *Sampling* of a signal means discretization of the …

X domain
O range
O all of the above

Problem 3: *Signal to noise ratio* of averaged images improves as the … of the number of images summed:

O Poisson distribution
O Gaussian
X square root

Problem 4: The process of approximating colors with a pattern of colors in a lower definition color space is called …

X dithering
O pixelation
O reconstruction

Problem 5: Which one of the following statements is *not* correct:

O histograms may be used to count the number of occurrence of RGB color values
O the sum of histogram values equals the image size
X probability density function is the histogram normalized by mean grey value

Problem 6: Which one of the following statements is *correct*:

O histogram equalization always results in a flat probability density function
O the best way to identify moving objects is by multiplication of images
X quantization can be thought of as multi-level thresholding

Problem 7: How many different binary (black or white) 3x3 images are conceivable?

2^9 = 512

Problem 8: What is the gradient of a 2D image (describe in words ore use formula)?

D = (d/dx d/dy)

Problem 9: What is magnitude z of the gradient, expressed as a function of x and y components (equation)?

Answer: z = sqrt (x^2+y^2)

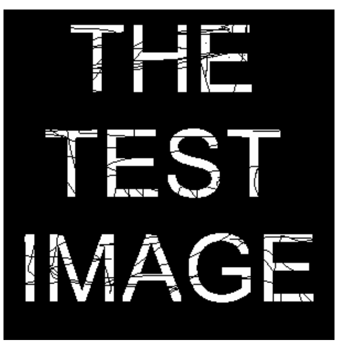
Problem 10: Compute the following convolution of a 1D integer array with a 1D kernel (write result as an array with 9 integers):

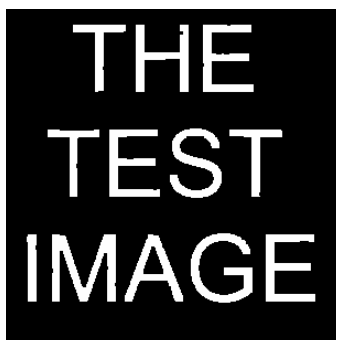
[0 0 1 0 3 0 1 0 0] ⊗ [1 2] = [0 0 1 2 3 6 1 2 0]

Problem 11: What is the name of the following operation (applied in succession to the image on left)?

O dilation
X erosion
O closing

Problem 12: What method removes the noise in the letters on the left?





O opening
O erosion
X closing

Problem 13: A *system* is a transformation that is …

O linear
O shift invariant
X all of the above

Problem 14: A square function convolved with a square function gives …

O a delta function
O a Shah function
X a triangle

Problem 15: A Gaussian convolved with a Gaussian gives …

X a Gaussian
O a delta function
O a parabola

Problem 16: The Fourier transform of a delta function is …

O a Shah function
X a constant
O a sine wave

Problem 17: The Fourier transform of a triangle function is …

O a Shah function
O a sinc function
X a squared sinc function

Problem 18: The Fourier transform of a Gaussian is …

O a Shah function
X a Gaussian
O a squared Gaussian

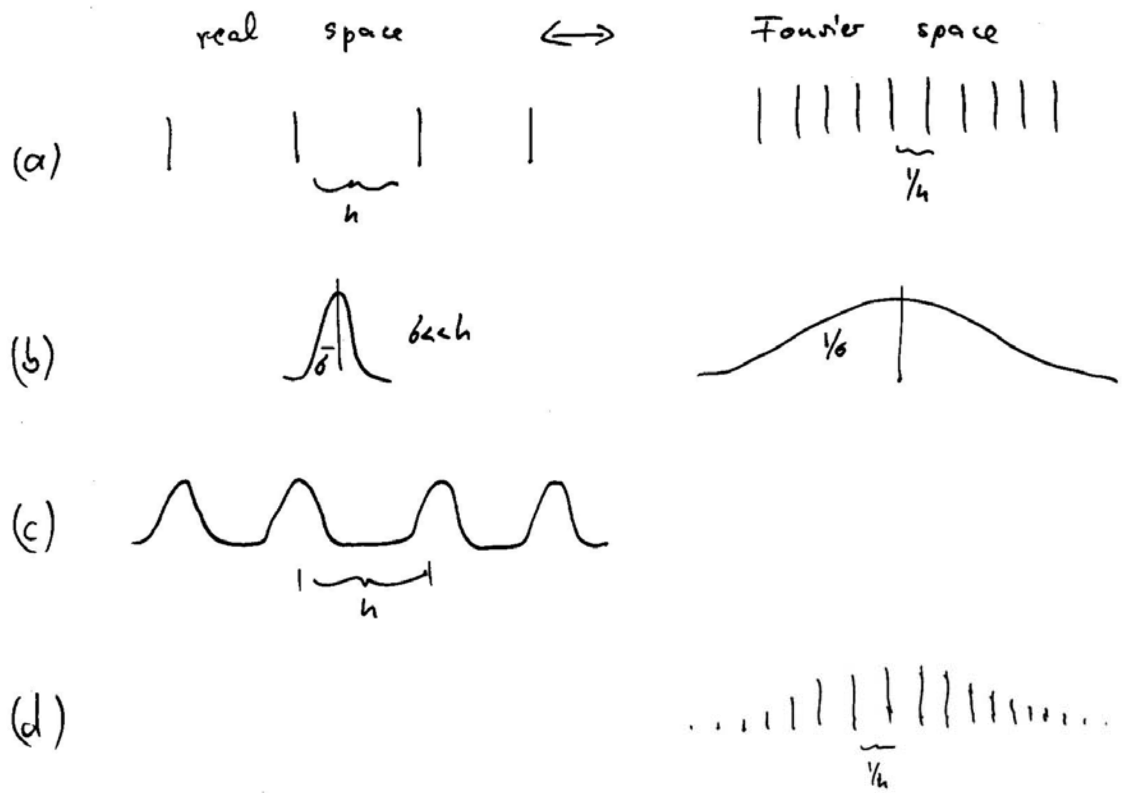
Problem 19: Fourier convolution theorem (use next page for sketches)

(a) sketch the *Fourier transform* of a Shah function with spacing h in direct space and indicate any spacing of features in Fourier space.

(b) sketch the *Fourier transform* of a Gaussian where $\sigma \ll h$ in direct space.

(c) sketch the direct space convolution of the Shah function with the Gaussian.

(d) using the Fourier convolution theorem, sketch the Fourier transform of (c).



real space
Fourier space
(a)
h
1/h
(b)
σ
each
1/σ
(c)
h
(d)
1/h

Problem 20: Deconvolution

A sharpening operation termed *deconvolution* attempts to sharpen features in direct space images by dividing the Fourier transform of the image by the Fourier transform of a blurring kernel (often modeled as a Gaussian), and then performing an inverse Fourier transform. Why does this application of the Fourier convolution theorem fail in practical situations i.e. when there is noise present? You may us the example from question 19 to answer this in a few sentences:

There are two problems: (1) division by Gaussian yields drastic amplification of high frequencies (division by small values). (2) Noise in the Fourier transform will match or exceed the attenuated signal at high frequencies (remember the signal is modulated by the Fourier transform of the blurring kernel, see 19 d). The original signal at high frequencies is therefore lost in the noise, and deconvolution merely amplifies the noise artifacts, it can not recover any of the original high frequency signal.