The University of Texas
ARLINGTON

EE5356 Digital Image Processing

Instructor: Dr. K.R. Rao

Spring 2015, Test 1

Thursday, 19 February 2015

2.00 – 3.20 PM (1 hour and 20 minutes)

Room 100 GS (Geo Science Building)

Room 110 UH (University Hall)

(CLOSED BOOK, CLOSED NOTES)

INSTRUCTIONS:

1. Closed books and closed notes.

2. Please show all the steps in your works.

4. You can work problems in any order.

5. Please print your name and student ID.

6. No cheating, no talking.

Name____

Student ID ____________________________________

1. What is visual quantization? Explain contrast quantization and pseudo random noise quantization with block diagrams for both. (Block diagrams carry 5 marks each) [20 points]

2. Define and explain clearly with figures: [20 points]
   a. Uniform Sampling
   b. Non-Uniform Sampling
   c. Nyquist Theorem
   d. Aliasing

3. Given a 512 x 512 grayscale (8 bpp) image. Write a MATLAB code to quantize it to 3 bits using Uniform Quantizer. (15 Marks)

   When is contouring effect observed ? (5 Marks).

4. Baud rate is defined as the number of bits transmitted per second. Generally, transmission is accomplished in packets consisting of a start bit, then a byte of information and a stop bit. Using these facts, how many minutes would it take to transmit a 512x512 image with 256 graylevels using a 36K modem? (1K = 1024) [5 points]

5. In the RETMA scanning convention, each complete scan of the target is called a frame, which contains 525 lines scanned at a rate of 30 frames per second. Keeping in mind that each frame is composed of interlaced fields, calculate the horizontal scan rate and the vertical scan rate. [5 points]

6. [10 points] The simplest and most common quantizer is the uniform quantizer. Let the output of an image sensor take values between 0.0 and 10.0. If the samples are quantized uniformly to 256 levels, then

(a) Determine the transition levels (t_k) and reconstruction levels (r_k).

(b) Write the quantization interval (q) in terms of (t_k) and (r_k).

(c) What is the value of (q)?

(7) [20 points]

Given $F[\cos 2m\pi x] = \frac{1}{2}\left[\delta(\xi_1 - m) + \delta(\xi_1 + m)\right]$

The Fourier transform of a uniformly sampled image is given by:

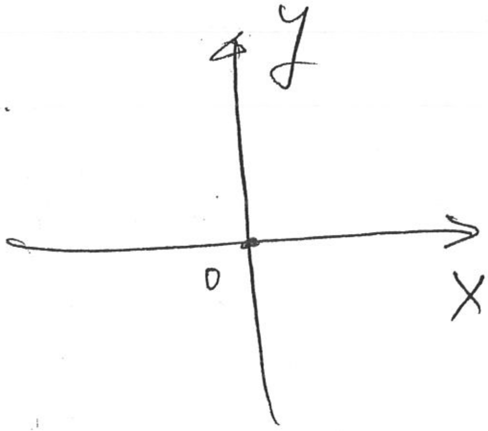
$$F_s(\xi_1, \xi_2) = \xi_{xs}\,\xi_{ys} \sum_{k,l=-\infty}^{\infty} F(\xi_1 - k\xi_{xs}, \xi_2 - l\xi_{ys})$$

$\xi_{xs} = \frac{1}{\Delta x}$, $\xi_{ys} = \frac{1}{\Delta y}$ (cycles/m) | Note $\left(\sum_{k,l=-\infty}^{\infty} = \sum_{k=-\infty}^{\infty} \sum_{l=-\infty}^{\infty} \right)$

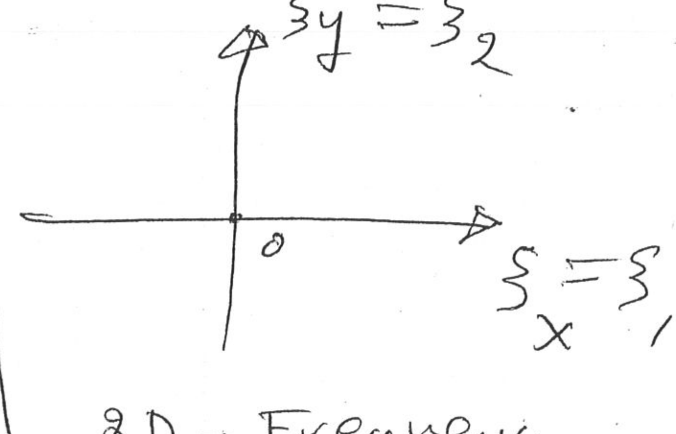
(cycles/m) ξ_{xs} and ξ_{ys} are the sampling intervals in the frequency domain, Δx and Δy are sampling intervals in spatial domain (in meters). (F = Fourier transform)

Sketch the low pass filter.

The image $f(x,y) = 4(\cos 4\pi x)(\cos 6\pi y)$ is sampled with $\Delta x = \Delta y = 0.5$. The reconstruction filter is an ideal low-pass filter with bandwidths $\left(\frac{1}{2\Delta x}, \frac{1}{2\Delta y}\right)$. What is the reconstructed image in ~~each~~ this case? Show all steps.



2D - Data Domain



2D - Frequency domain