Image Processing Lab
Sem 1
Lab 2: Basics of Signal Processing
16/08/2018

1.Try to complete the lab questions during the lab time (in lab submission)
2.Please do not copy programs.

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1. **Basic Signal Operations**
   Let x[n] be a signal with $x[n] = [1, 2, 5, 6, 3, 2, 1, 1, 1]$
   Sketch the following signals:
   (a) $x[n-4]$

   (b) $x[-n]$

   (c) $x[2-n]$

   (d) $2x[n]$

   (e) $x[3n]$

   (f) $x[n/3]$

2. **1-D convolution**
   Perform the following 1-D convolutions between signals x[n] and h[n]:
   (a) $x[n] = [1, 1, 1, 1, 1]$, $h[n] = [0, 0, 1, 1, 1, 1, 1, 1, 0]$

   (b) $x[n] = (-0.5)^n u[n-4]$, $h[n] = 4^n[2-n]$

   (c) Consider the evaluation of $y[n] = x_1[n] * x_2[n] * x_3[n]$
   where, $x_1[n] = (0.5)^n u[n]$,$x_2[n] = u[n-3]$,$x_3[n] = \delta[n] - \delta[n-1]$.

   Hint : You have to define the range of n appropriately.

3. **2-D convolutions**
   Perform the following 2-D convolutions and comment on the kind of filtering obtained in the result.

   (a)
   $$X = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 6 & 7 & 8 \end{bmatrix}, H = \begin{bmatrix} 1 & -2 & -1 \\ 1 & 0 & -1 \\ 1 & 2 & -1 \end{bmatrix}$$

   (b) Use the cameraman image as input and the kernel to be
   $$H = \frac{1}{9} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

   (c) Use the cameraman image as input and the kernel to be
   $$H = \begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$

4. **Convolution as multiplication**
   Prove that convolution in spatial domain is multiplication in frequency domain by applying FFT.

   (a) Find the FFT of the cameraman image and display the magnitude spectrum

   (b) Find the FFT of the kernel in question 3(b)

   (c) Multiply the two FFTs and take Inverse FFT of the product

   (d) Compare it with your result in question 3(b)