Image Processing Lab
Sem 1
Lab 3: Sampling and SVD
23/08/2018

1.Try to complete the lab questions during the lab time (in lab submission)
2.Please do not copy programs.
3.Please find the peppers.png image in the Resources folder.

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1. **Sampling an image**
   Use the peppers image and perform the following:
   (a) Downsample the image in spatial domain by removing alternate columns and rows , by a factor of 2 and 4
   (b) Reconstruct the image from the downsampled one by interpolation. Use bilinear interpolation in both cases and comment on the results obtained.
   (c) Comment on the various interpolation methods ,aliasing and about how you can avoid aliasing.

   Note:

   1. Bilinear interpolation equations:
      $output[2m][2n] = input[m][n]$
      $output[2m][2n+1] = (input[m][n] + input[m][n+1])/2$
      $output[2m+1][2n] = (input[m][n] + input[m+1][n])/2$
      $output[2m+1][2n+1] = (input[m][n]+input[m+1][n]+input[m][n+1]+input[m+1][n+1])/4$
   2. For the factor of 4, do bilinear interpolations twice to reach the original image size.

2. **Eigen values and Singular values**
   Find the eigen values and singular values of the matrix

$$A = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 0 \end{bmatrix}$$

   Explore further on the relation between eigen values and singular values.

3. **Singular Value Decomposition**

   (a) Perform SVD on the given image and identify its eigen images.

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

   (b) Show the different stages of SVD of the following image:

$$A = \begin{bmatrix} 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 \\ 255 & 255 & 255 & 100 & 100 & 100 & 255 & 255 \\ 255 & 255 & 100 & 150 & 150 & 150 & 100 & 255 \\ 255 & 255 & 100 & 150 & 200 & 150 & 100 & 255 \\ 255 & 255 & 100 & 150 & 150 & 150 & 100 & 255 \\ 255 & 255 & 255 & 100 & 100 & 100 & 255 & 255 \\ 255 & 255 & 255 & 255 & 50 & 255 & 255 & 255 \\ 50 & 50 & 50 & 50 & 255 & 255 & 255 & 255 \end{bmatrix}$$

4. **Approximating using SVD**

   (a) Use the cameraman image and find its singular values

   (b) Choose some value k < n, where n is the rank of Σ, the singular matrix

   (c) Keep the first k singular values and the rest zeroes to get $\hat{\Sigma}$

   (d) Reconstruct the image using these singular vallues

   (e) Calculate the error

   (f) Plot the error as a function of k

   (g) Add some random noise to your input image and do similar approximation.Infer your results.