Department of Computer Science and Engineering

C6173D IMAGE PROCESSING *Assignment I*

Posted on 2nd March 2021 / Submission on 14th March 2021

1 Theoretical and Numerical Questions

Answer at least 3 questions from out of the 5 questions.

1. Compute the Fourier Transform for the following functions.

   (a)
   $$sin(x)$$

   (b)
   $$cos(x)$$

   (c)
   $$cos(4\pi x)$$

   (d)
   $$e^{-j8\pi x}$$

   (e)
   $$2 + cos(2\pi x) - jsin(2\pi x) + cos(3\pi x) - jsin(3\pi x)$$

2. Prove the linearity property of 1D Continuous Fourier Transform.

3. Consider the function given below.
   f(x) =
   $$\begin{cases} 1, \frac{-a}{2} \leq x \leq \frac{a}{2} \\ 0, otherwise \end{cases}$$
   Prove the time shifting property of Fourier Transform for f(x−2).

4. Compute the 2D basis vectors of 2D DFT using the separability property of DFT.

5. Compute the 2D basis vectors of 2D DCT using the separability property of DCT.

2 Programming Questions

Answer at least 5 questions from out of the 9 questions. You may choose Python or MATLAB.

6. Write a program to read and display a sample gray level image of size 256*256 (Standard MATLAB images such as Cameraman, Lena etc.). Find the maximum and minimum intensity values in the image.

7. Create an image of size 64x64 where

$$I(i,j) = \left| cos\sqrt{(i^2 + j^2)} \right|$$

   Display the image?

8. Quantize the intensity levels in the above image by dividing the range [0,1] into four equal intervals. Quantization happens according to the following table.

Image gray level	Output gary level
0≤ I < 0.25	0
0.25≤ I < 0.5	0.25
0.5≤ I < 0.75	0.5
0.75≤ I < 1	0.75
1	1

9. 4 level quantization of the intensities of the image in Question 1.(max_intensity interval divided into 4 equal intervals and follow the scheme in the previous question).

10. 8 level quantization of the intensities of the image Question 1.(max_intensity interval divided into 8 equal intervals and follow the scheme in the previous question). Observe the difference in image quality (with image in question 5).

11. Perform following operations on the given image.

    (a) Find DFT of the given image.

    (b) Find the magnitude spectrum.

    (c) Find the phase spectrum.

    (d) Double the magnitude spectrum.

    (e) Reconstruct the image using the IDFT.

    (f) Reconstruct the image removing phase spectrum.

    (g) Put the results together in one window.

Explain your results

12. Pick an image and follow the operations

    (a) Multiply image by $(-1)^{x+y}$.

    (b) Compute the DFT.

    (c) Take the complex conjugate of the transform.

    (d) Compute the IDFT.

    (e) Multiply the real part of the result by $(-1)^{x+y}$.

    Compare the input image and output image. Explain (mathematically) why the output image appear as it does.

13. Obtain the Fourier spectrum of a given image. Pad the image with zero's, obtain Fourier spectrum.

    (a) Explain the difference in overall contrast

    (b) Explain the significant increase in signal strength along the vertical and horizontal axes of spectrum on the second output image.

14. What is the result of two DFTs performed in succession? Apply a DFT to an image, and then again DFT to the resultant image. Can you account for what you see?

Outputs Required

- Create Assignment1.tar file containing code for all questions with the following naming convention.
  $EXE < number > \_ < rollnumber > \_ < firstname > \_ < questionnumber > if < partnumber > . < extension >$

- Output images with naming convention $< questionnumber > if < partnumber >$

- Observations (comparing images) in a Text file for question 2 and 6 with naming convention $< questionnumber > if < partnumber >$.