Homework 4 (Due: 5/20)

(1) Write a Matlab or Python program to measure the structural similarity (SSIM) of two images A and B. The sizes of A and B are equivalent.

SSIM(A, B, c1, c2)

where c1 and c2 are some adjust constants.

The Matlab or Python code should be handed out by NTUCool. (20 scores)

(2) How do we implement the following 5-point DCT with the least number of nontrivial multiplications?

$$X[m]=\sum_{n=0}^{4}\cos\left(\frac{\pi}{5}m(n+\frac{1}{2})\right)x[n] \qquad \begin{matrix} n=0,1,2,3,4 \\ m=0,1,2,3,4 \end{matrix}$$

(10 scores)

The process and the number of real multiplications should be shown.

(3) Suppose that x is a complex number. What are the constraints of θ such that the multiplication of x and $\exp(j\,\theta)$ required only 2 real multiplications?

(10 scores)

(4) Determining the numbers of real multiplications for the (a) 220-point DFT, (b) 231-point DFT, and the (c) 245-point DFT. (15 scores)

(5) What are the two main advantages of the sectioned convolution? (10 scores)

(6) Suppose that a smooth filter is:

$x_s[n] = x[n] * h[n]$ $h[1] = h[-1] = 0.24$ $h[2] = h[-2] = 0.06$

$h[3] = h[-3] = 0.03$ $h[0] = 0.34$ $h[n] = 0$ otherwise

Design an efficient way with least number of non-trivial real multiplications to implement the above filter operation. (10 scores)

(7) Suppose that length($x[n]$) = 1100. What is the best way to implement the convolution of $x[n]$ and $y[n]$ if

(a) length($y[n]$) = 200, (b) length($y[n]$) = 20,

(c) length($y[n]$) = 7, and (d) length($y[n]$) = 2?

Also show the number of real multiplications required for each case.

(25 scores)

(Extra): Answer the questions according to your student ID number.

(ended with (2, 7), (3, 8), (4, 9), (0, 5))