

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.

$$\text{SSIM}(A, B, c1, c2)$$

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?

$$X[m] = \sum_{n=0}^4 \cos\left(\frac{\pi}{5} m\left(n + \frac{1}{2}\right)\right) x[n] \quad \begin{matrix} n=0,1,2,3,4 \\ m=0,1,2,3,4 \end{matrix} \quad (10 \text{ scores})$$

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:

$$\begin{aligned}x_s[n] &= x[n] * h[n] & h[1] &= h[-1] = 0.24 & h[2] &= h[-2] = 0.06 \\ h[3] &= h[-3] = 0.03 & h[0] &= 0.34 & h[n] &= 0 \text{ otherwise}\end{aligned}$$

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

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

(a) $\text{length}(y[n]) = 200$, (b) $\text{length}(y[n]) = 20$,

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

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))