Homework 4 (Due: 5/24)

(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) (a) How do we use three real multiplications to implement a complex multiplication? (10 scores)

(b) Suppose that

$$\begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \end{bmatrix} = \begin{bmatrix} b_1 & -b_2 & -b_3 & -b_4 \\ b_2 & b_1 & b_4 & -b_3 \\ b_3 & b_4 & b_1 & -b_2 \\ -b_4 & b_3 & b_2 & b_1 \end{bmatrix} \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \end{bmatrix}$$

How do we implement above matrix operation with the least number of real multiplications? (10 scores)

(3) Determining the numbers of real multiplications for the (a) 125-point DFT, (b) the 147-point DFT, and (c) the 385-point DFT. (15 scores)

(4) What is the complexity of the 3D DFT as follows? Express the solution in terms of the big order. (10 scores)

$$Y[p,q,r]=\sum_{m=0}^{M-1}\sum_{n=0}^{N-1}\sum_{k=0}^{K-1}e^{-j2\pi\frac{pm}{M}-j2\pi\frac{qn}{N}-j2\pi\frac{rk}{K}}x[m,n,k]$$

(5) Suppose that there are 1200 cars in a dataset and an algorithm detects 1000 cars. However, among the detected cars, 100 of them are in fact other objects. Determine the precision, the recall, and the F-score of the algorithm. (10 scores)

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

(a) length($y[n]$) = 500, (b) length($y[n]$) = 40,

(c) length($y[n]$) = 6, and (d) length($y[n]$) = 2 ? (25 scores)

Please show (i) the convolution method (direct, sectioned convolution, or non-sectioned convolution), (ii) the number of points of the FFT, (iii) and the number of real multiplications for the best implementation method. Also, consider the general case where $x[n]$ and $y[n]$ are complex sequences and the FFT of $y[n]$ can be computed in prior.

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

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