

Homework 4 (Due: 6/9)

- (1) Write the Matlab program to compute the FFT of two N -point real signals x and y using only one N -point FFT. (20 scores)

$$[Fx, Fy] = \text{fftrealm}(x, y)$$

The Matlab file should be mailed to displab531@gmail.com.

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

- (3) How do we implement the following matrix operations with the least number of multiplications?

$$(a) \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} = \begin{bmatrix} b & a & b \\ a & b & a \\ b & a & b \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

$$(b) \begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \end{bmatrix} = \begin{bmatrix} a & b & c & d \\ b & -d & -a & -c \\ c & -a & d & b \\ d & -c & b & -a \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix}$$

(20 scores)

- (4) Determining the numbers of real multiplications for the (a) 100-point DFT, (b) 176-point DFT, and the (c) 338-point DFT. (15 scores)

- (5) Suppose that a 1-D ridge detection filter is:

$$\begin{aligned}x_s[n] &= x[n] * h[n] & h[1] &= h[-1] = -0.3 & h[2] &= h[-2] = -0.125 \\ h[3] &= h[-3] = -0.075 & h[0] &= 1 & h[n] &= 0 \text{ otherwise}\end{aligned}$$

Design an efficient way to implement the above filter operation.

(10 scores)

- (6) Suppose that $\text{length}(x[n]) = 1200$. What is the best way to implement the convolution of $x[n]$ and $y[n]$ if

(a) $\text{length}(y[n]) = 600$, (b) $\text{length}(y[n]) = 50$,

(c) $\text{length}(y[n]) = 9$, and (d) $\text{length}(y[n]) = 3$? (25 scores)