SNS COLLEGE OF ENGINEERING

(Autonomous)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

UNIT- I

Discrete Fourier Transform

Filtering Methods based on DFT- Overlap Save Method

FILTERING METHODS BASED ON DFT :

For linear convolution input sequence x(n) of long duration is to be processed with a system having impulse response h(n) of finite duration by convolving the two sequences.

Because of the length of the input sequence, it could not be practical to store before performing linear convolution. Therefore the input sequence must be divided into blocks.

The successive blocks are processed separately one at a time and the results are combined to obtain linear convolution.

There are two methods namely,

8m theory can be [illegible]ed

i) overlap add method

ii) overlap save method.

Overlap save method :-

STEP. 1 :

Let the length of the i/p sequence x(n) be 'L' and the length of the impulse response h(n) be 'M''

Scanned with CamScanner

STEP. 2 :

Input sequence is divided into blocks of data of size (L > M)

STEP 3 :

Each block consist of last (M−1) data points, of previous block followed by 'L' new data points to form a data sequence $x_i(n)$.

STEP. 4 :

for first block of data the first (M−1) pts are set to zero.

STEP. 5 :

Compute circular convolution of $x_i(n)$ with h(n) i.e., $y_i(n) = x_i(n) \circledast h(n)$

STEP. 6 :

Due to aliasing discard the first (M−1) pts of the filtered section $y_i(n)$.

The remaining points from successive pointers of them added to construct the final filtered output.

Find the o/p y(n) of a filter whose impulse response is $h(n) = \{1, 1, 1\}$ and $x(n) = \{3, -1, 0, 1, 3, 2, 0, 1, 2, 1\}$ using <u>overlap save method</u>.

<u>Sol:</u> <u>STEP. 1:</u>

$x(n) = \{3, -1, 0, 1, 3, 2, 0, 1, 2, 1\} \Rightarrow L_s = 10$

$h(n) = \{1, 1, 1\} \Rightarrow M = 3$

By linear convolution,

$$N = L + M - 1$$
$$= 10 + 3 - 1$$
$$\boxed{N = 12}$$

Scanned with CamScanner

STEP 2:

$L > M$

$4 > 3$

$\boxed{L = 4}$

STEP 3:

$x(n) = \{3, -1, 0, 1 / 3, 2, 0, 1 / 2, 1\}$

$x_1(n) = \{\underbrace{0, 0}_{(M-1)\text{ zeros}}, 3, -1, 0, 1\}$

$x_2(n) = \{\underbrace{0, 1}_{(m-1)\text{ data of previous block}}, 3, 2, 0, 1\}$

$x_3(n) = \{\underbrace{0, 1}_{(m-1)\text{ data of previous block}}, 2, 1, 0, 0\}$

STEP 4:

$y_i(n) = x_i(n) \circledast h(n)$

$1 \times 0 + 0 + 0 + 0 + 0 = 1$

$L = 6, \; m = 3$

$x_1(n) = \{0, 0, 3, -1, 0, 1\}$

$h(n) = \{1, 1, 1, 0, 0, 0\}$

matrix method

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 3 \\ -1 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 3 \\ 2 \\ 2 \\ 0 \end{bmatrix} = y_1(n) \quad 3-\frac{1}{2}$$

$x_2(n) = \{0, 1, 3, 2, 0, 1\}$

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \\ 3 \\ 2 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 4 \\ 6 \\ 5 \\ 3 \end{bmatrix} = y_2(n)$$

$x_3(n) = \{0, 1, 2, 1, 0, 0\}$

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \\ 2 \\ 1 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ 3 \\ 4 \\ 3 \\ 1 \end{bmatrix} = y_3(n)$$

$y_1(n) = \{\cancel{1}, \cancel{1}, 3, 2, 2, 0\}$

$y_2(n) = \{\cancel{1}, \cancel{2}, 4, 6, 5, 3\}$

$y_3(n) = \{\cancel{0}, \cancel{1}, 3, 4, 3, 1\}$

$\because \boxed{M = 3}$

$(M-1) = 2$ terms discard.

RESULT:

$y(n) = \{3, 2, 2, 0, 4, 6, 5, 3, 3, 4, 3, 1\}$

Thank You!