DIGITAL SIGNAL PROCESSING

Chapter 10
Inverse Discrete Fourier Transform (iDFT)

Filter design

- Aims
  - To explain the characteristic and response of the discrete-time signal in frequency domain and to obtain back the discrete-time signal from its frequency domain.

- Expected Outcomes
  - Upon completion of the topic, students should be able to convert and analyze the discrete-time signals in frequency-time domain and obtain back the discrete-time signal using inverse Discrete Fourier Transform technique.

Definition of iDFT

- IDFT is the inverse Discrete Fourier Transform.
- The finite length sequence can be obtained from the Discrete Fourier Transform by performing IDFT.
- The IDFT is defined as :

$$x(n) = 1/N \sum_{k=0}^{N-1} X(k) e^{2\pi nk/N},$$

where n = 0,1, …, N-1

iDFT Example

- **EXAMPLE 1**

  Determine the IDFT for the following DFT sequence, X(k) = {1, 2, 3, 4}

  SOLUTION:

1. Determine the length of the sequence, N = 4
2. Calculate the IDFT by the IDFT formula:

$$x(n) = 1/4 \sum_{k=0}^{3} \boldsymbol{X(k)}\, e^{j2\pi nk/4},$$

$x(0) = ¼(1 + 2 + 3 + 4) = 5/2$

$x(1) = -0.5 – j0.5,\ \ x(2) = -0.5$

$x(3) = -0.5 + j0.5$

3. Thus the finite length sequence, $x(n)$ is:

$x(n)$ = {2.5, -0.5-j0.5, -0.5, -0.5+j0.5}

iDFT Example

- **EXAMPLE 2:**

  Obtain the finite length sequence, $x(n)$ from the DFT sequence in Example 3.

  Solution:

1. The sequence in Example 3 is :

   $X_3(k) = \{60, 0, -4, 0\}$

2. Use IDFT formula to obtain $x(n)$:

$$x_3(n) = 1/4 \sum_{k=0}^{3} \boldsymbol{X(k)} e^{j2\pi nk/4},$$

$$x_3(0) = 14, \quad x_3(1) = 16, \quad x_3(2) = 14, \quad x_3(3) = 16$$

Thus the finite length sequences are :

$$\boldsymbol{x_3(k) = \{14, 16, 14, 16\}}$$

iDFT

- The DFT & IDFT can be summarized below:

➢ 1. It is a powerful method to perform frequency analysis which are used widely in digital image processing including blurring and enhancing.

➢ 2. Since the DFT & IDFT will become tedious when the length of the sequence become big, one algorithm is develop to overcome this problem.

➢ 3. The algorithm can be found in MATLAB. The function are :

1. **FFT2( )** = to perform DFT
2. **IFFT2( )** = to perform IDFT

INVERSE DISCRETE FOURIER TRANSFORM

To obtain response and characteristic of the discrete-time signal using iDFT

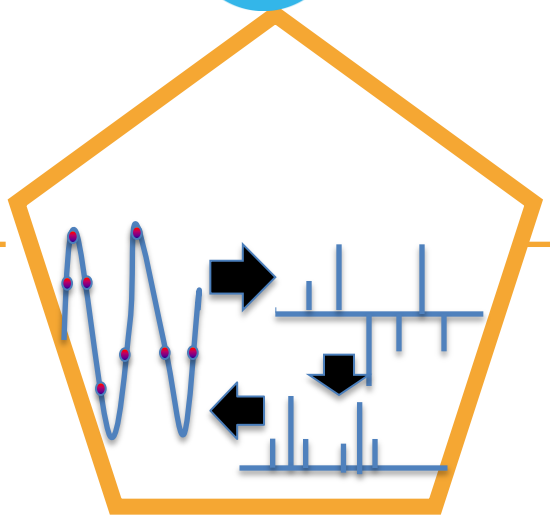
5

4

To use iDFT to obtain the discrete-time signal from frequency domain

1

To obtain discrete-time signals



3

To study the characteristic of the iDFT in providing the response of the discrete-time signals

2

To convert the discrete-time signals in the frequency domain into time domain

Conclusion of The Chapter

- Able to obtain discrete-time signal from frequency domain using inverse DFT technique.
- Able to perform analysis of the discrete-time signal in frequency time domain and then convert the discrete-time signal back to the time domain using inverse DFT technique.
- Able to perform discrete-signal convolution using inverse DFT technique.

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