AL- MUSTAQBAL UNIVERSITY COLLEGE
DEPARTMENT OF BIOMEDICAL ENGINEERING

Signals and Systems for BME

BME 322

Lecture 5

- Finite Impulse Response (FIR) Filters -

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Finite Impulse Response (FIR) Filters

- FIR filters are nonrecursive filters.
- The input-output relation of the FIR filters in time domain:

$$y[n] = \sum_{K=0}^{M} b_k \, x[n-k]$$

b_k are the filter coefficients

Finite Impulse Response (FIR) Filters

- FIR filters have a finite-duration impulse response.
- FIR filters take the number of samples equals to the number of past inputs for the impulse response to become zero.
- This FIR filter has the effect of averaging every N samples in the input signal.
- Any filter with this type of impulse response is called as a moving average filter.

Examples

A FIR filter has a set of filter coefficients {bk} = {3, -1, 2, 1}. Determine the difference equation for the filter.

Sol:

The length of the filter is 4.

$$y\,[n] = 3x[n]\; - x[n-1]\; + 2x[n-2] + x[n-3]$$

Examples

Determine the first four samples in the impulse response for the FIR filter.

$$y\,[n] = 0.5(x[n]\ + x[n-1]\ + x[n-2])$$

Sol:

Substituting δ[n] for $x\,[n]$ and h[n] for $y\,[n]$.

$$h\,[n] = 0.5(\delta\,[n] + \delta\,[n-1]\ + \delta\,[n-2])$$

$$h\,[0] = 0.5(\delta\,[0] + \delta\,[-1]\ + \delta\,[-2])$$
$$= 0.5(1.0 + 0.0 + 0.0) = 0.5$$

Examples

$$h\,[1] = 0.5(\delta\,[1] + \delta\,[0] + \delta\,[-1])$$
$$= 0.5(0.0 + 1.0 + 0.0) = 0.5$$

$$h\,[2] = 0.5(\delta\,[2] + \delta\,[1] + \delta\,[0])$$
$$= 0.5(0.0 + 0.0 + 1.0) = 0.5$$

$$h\,[3] = 0.5(\delta\,[3] + \delta\,[2] + \delta\,[1])$$
$$= 0.5(0.0 + 0.0 + 0.0) = 0$$

Examples

Determine the first six samples in the impulse response for the FIR filter.

$$y\,[n] = 0.25(x[n]\ + x[n-1]\ + x[n-2]\ + x[n-3])$$

Sol:

Substituting δ[n] for $x\ [n]$ and h[n] for $y\ [n]$.

$$h\,[n] = 0.25(\delta\,[n] + \delta\,[n-1]\ + \delta\,[n-2] + \delta\,[n-3])$$

$$h\,[0] = 0.25(\delta\,[0] + \delta\,[-1]\ + \delta\,[-2] + \delta\,[-3])$$
$$= 0.25(1.0 + 0.0 + 0.0 + 0.0) = 0.25$$

Examples of Systems

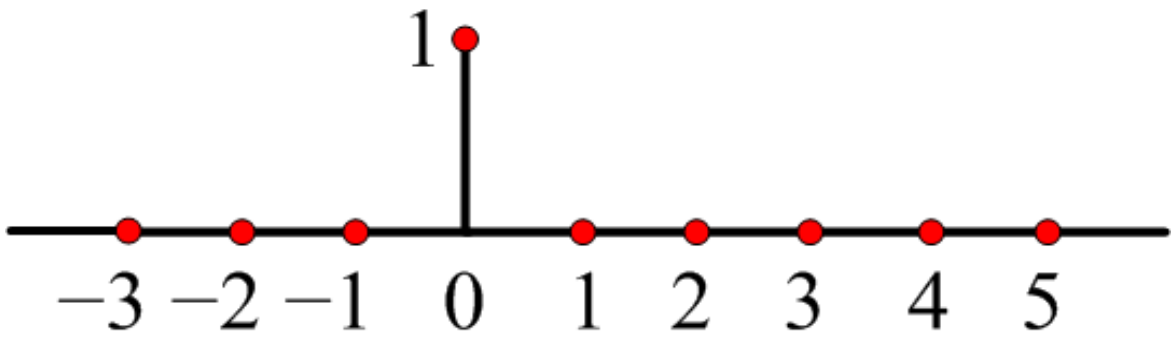
$$h\,[1] = 0.25(\delta\,[1] + \delta\,[0] + \delta\,[-1] + \delta\,[-2]\,)$$
$$= 0.25(0.0 + 1.0 + 0.0 + 0.0) = 0.25$$

$$h\,[2] = 0.25(\delta\,[2] + \delta\,[1] + \delta\,[0] + \delta\,[-1]\,)$$
$$= 0.25(0.0 + 0.0 + 1.0 + 0.0) = 0.25$$

$$h\,[3] = 0.25(\delta\,[3] + \delta\,[2] + \delta\,[1] + \delta\,[0]\,)$$
$$= 0.25(0.0 + 0.0 + 0.0 + 1.0) = 0.25$$

$$h\,[4] = 0.25(\delta\,[4] + \delta\,[3] + \delta\,[2] + \delta\,[1]\,)$$
$$= 0.25(0.0 + 0.0 + 0.0 + 0.0) = 0.0$$

$$h\,[5] = 0.25(\delta\,[5] + \delta\,[4] + \delta\,[3] + \delta\,[2]\,)$$
$$= 0.25(0.0 + 0.0 + 0.0 + 0.0) = 0.0$$



Impulse Function