Digital Filter Structures summary

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Digital Filter Structures

- IIR Filter Structures
  - Direct Filter Structure
  - Cascade Filter Structure
  - Parallel Filter Structure
  - Transposed Filter Structure
- FIR Filter Structures
  - Direct Filter Structure
  - Cascade Filter Structure
  - Parallel Filter Structure
  - Frequency Sampling Structure

Digital Filter Structures

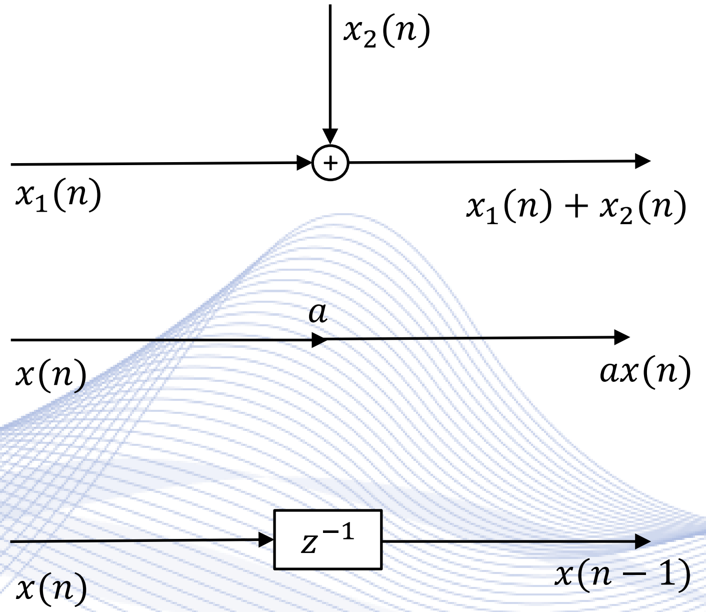
Criteria for suitable structure

1. Number of additions and multiplications
2. Number of additions and multiplications (for parallel implementation)
3. Number of registers and delay units
4. Calculation speed for serial or parallel implementation
5. Characteristic diagrams of errors

Digital Filter Structures

Fundamental blocks

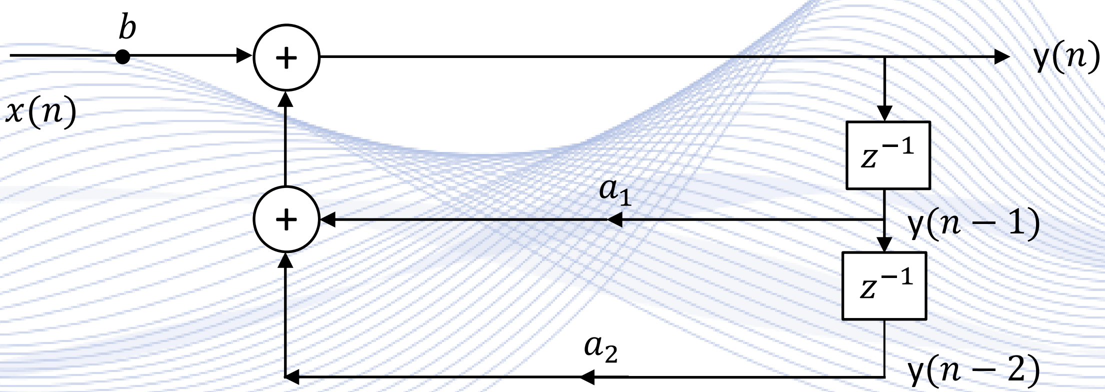
a) Adders
b) Multipliers
c) Delay units



Digital Filter Structures

Implementation of the secondary IIR digital filter based on the fundamental blocks:

$$y(n) = a_1(n-1) + a_2 y(n-2) + bx(n)$$



Digital Filter Structures

- **IIR Filter Structure**
- FIR Filter Structure

Digital Filter Structures : IIR

Structures

- Direct Filter Structure I
- Irregular Filter Structure II
- Direct Filter Structure II
- Cascade Filter Structure
- Parallel Filter Structure
- Transposed Direct Filter Structure I
- Transposed Direct Filter Structure II

Digital Filter Structures : IIR

An IIR filter with the following transfer function:

$$H(z) = \frac{\sum_{k=0}^{M} b_k \, z^{-k}}{1 - \sum_{k=0}^{N} a_k \, z^{-k}}$$

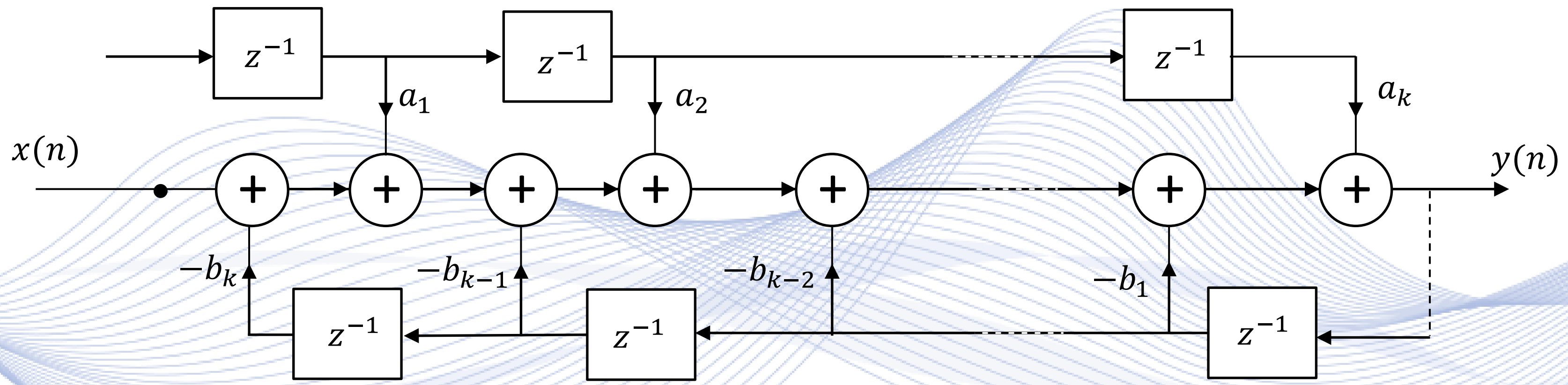
can be described by the function:

$$y(n) = \sum_{k=0}^{N} a_k y(n-k) + \sum_{k=0}^{M} b_k y(n-k)$$

Digital Filter Structures : IIR

Direct Filter Structure I

A simple implementation of the IIR filter described.



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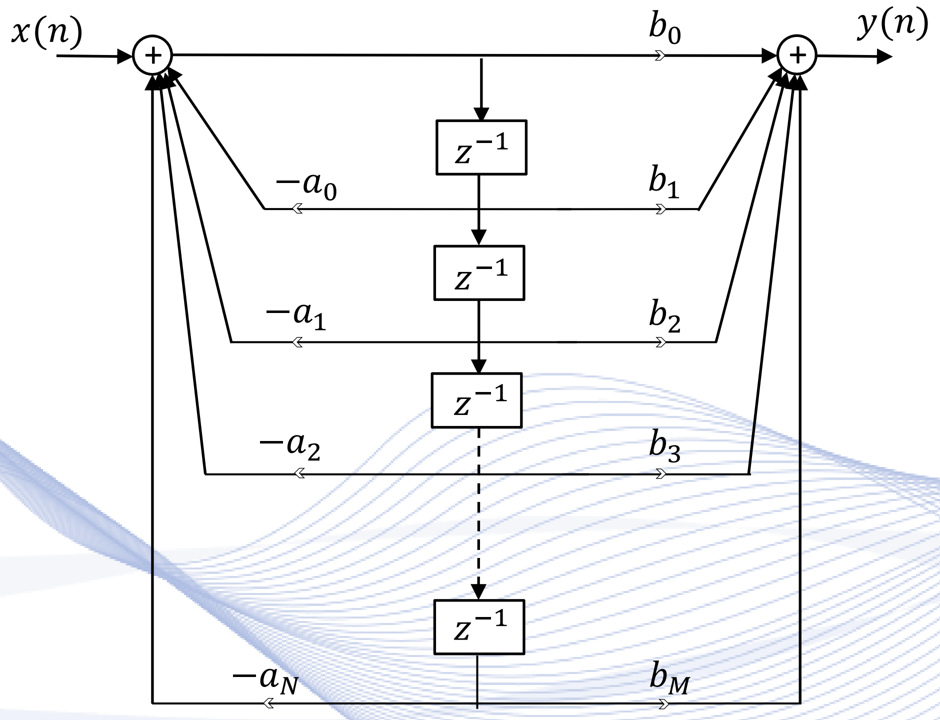
Digital Filter Structures : IIR

Direct Filter Structure II

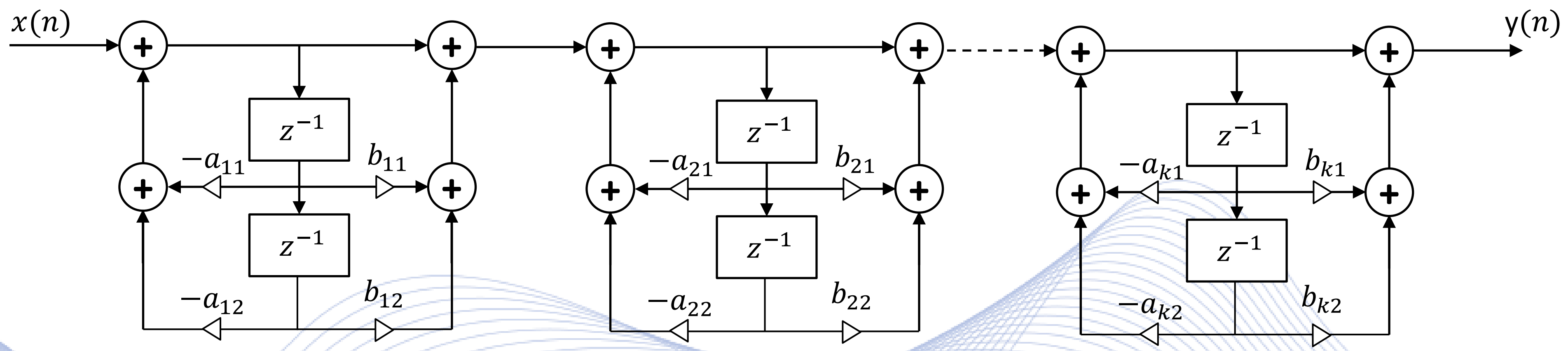


The delay lines are merged into one.

Minimum number of delays is achieved.

Digital Filter Structures : IIR

Cascade Filter Structure



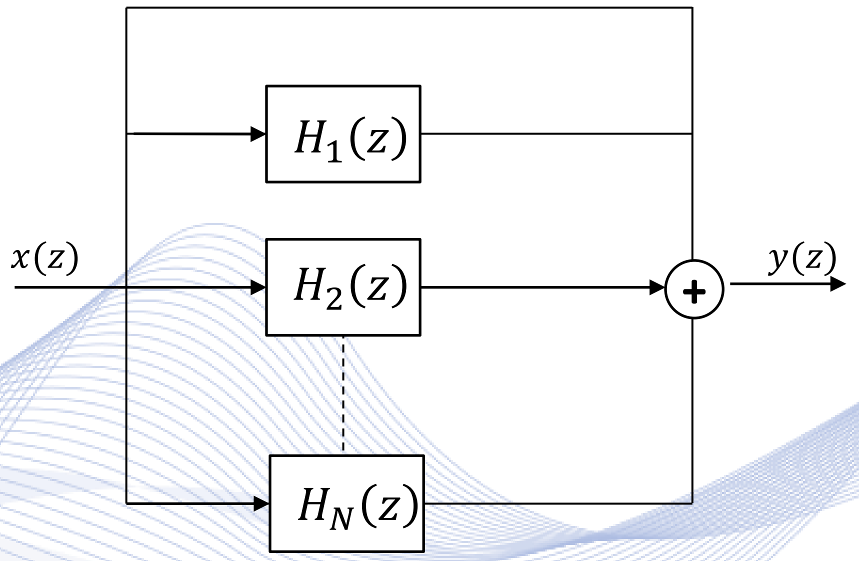
Used in the implementation of digital filters, because there is only one elementary block whose coefficients are changing.

Digital Filter Structures : IIR

Parallel Filter Structure

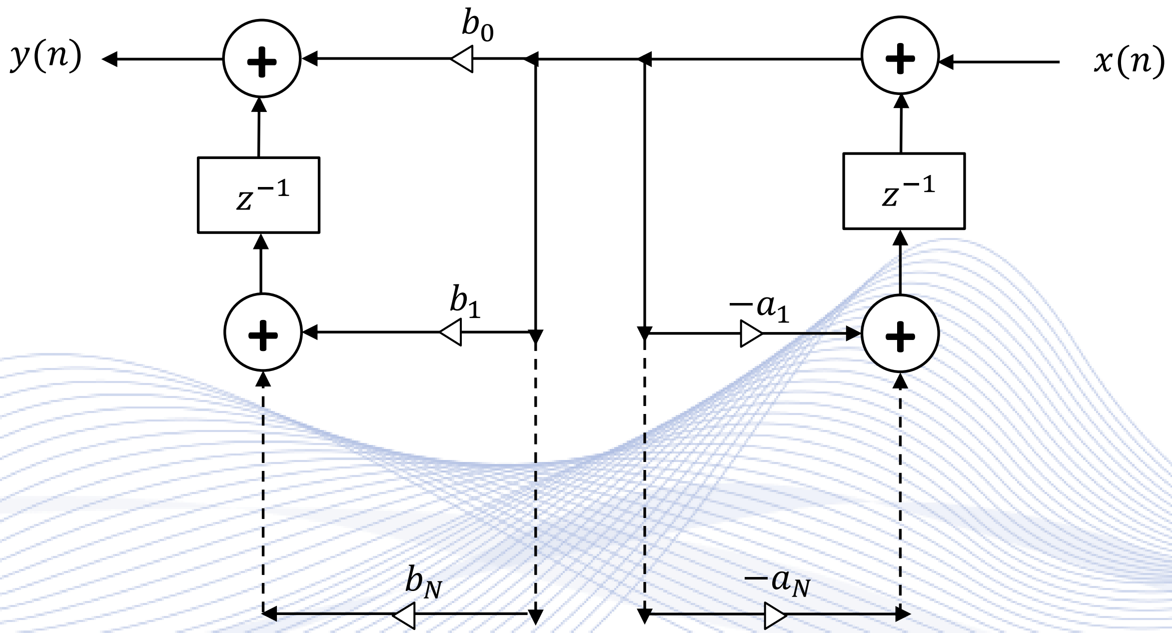
If $M < N\ then$:

$$H(z) = \sum_{k=1}^{[(N+1)/2]} \frac{\gamma_{0k} + \gamma_{1k} z^{-1}}{1 - \alpha_{1k} z^{-1} - \alpha_{2k} z^{-2}}$$



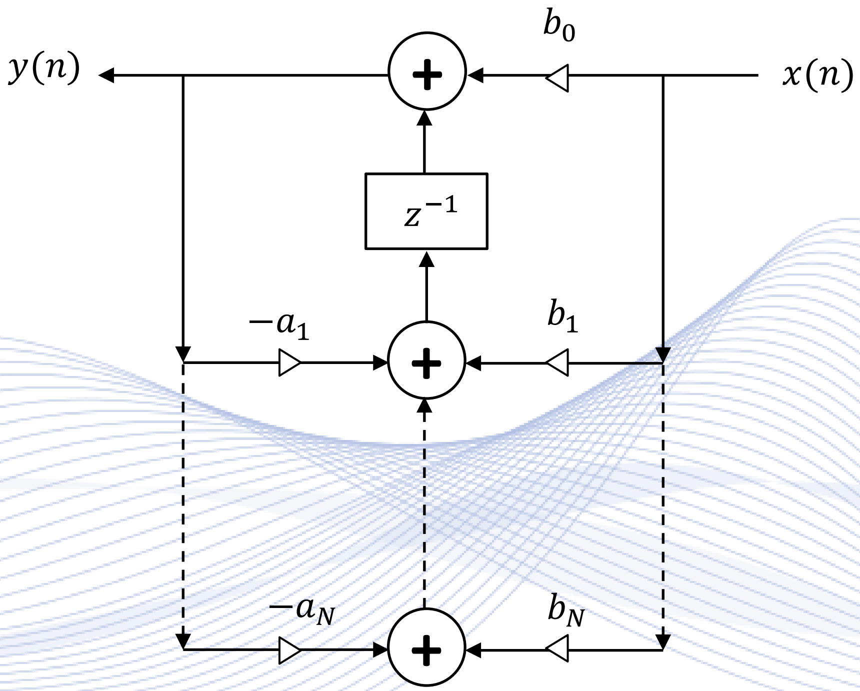
Digital Filter Structures : IIR

Transposed Direct Filter Structure I



Digital Filter Structures : IIR

Transposed Direct Filter Structure II



Digital Filter Structures

- IIR Filter Structure
- **FIR Filter Structure**

Digital Filter Structures : FIR

Structures

- Direct Filter Structure
- Transposed Direct Filter Structure
- Cascade Filter Structure
- Lagrange Filter Structure
- Frequency Sampling Structure
- Linear Phase Even Structure
- Linear Phase Odd Structure

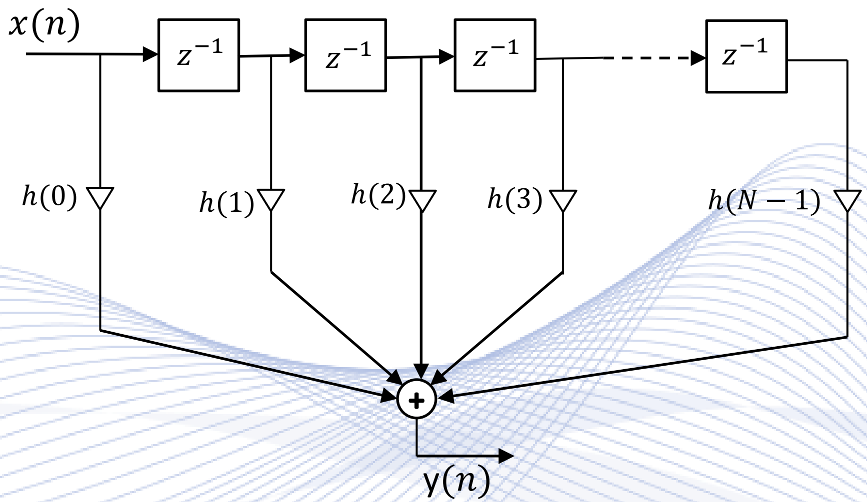
Digital Filter Structures : FIR

FIR filter is described by the equation:

$$H(z) = \sum_{n=0}^{N-1} h(n) z^{-n}$$

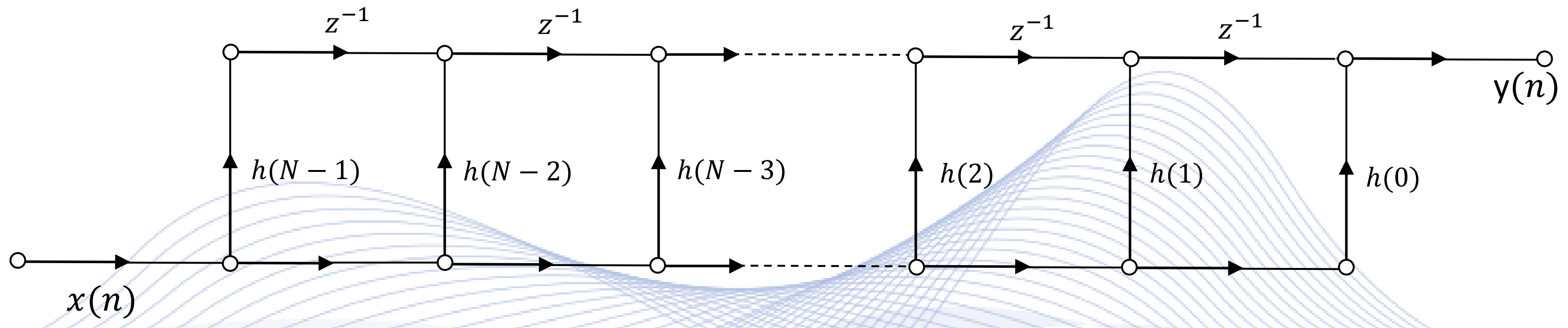
Digital Filter Structures : FIR

Direct Filter Structure



Digital Filter Structures : FIR

Transposed Direct Filter Structure



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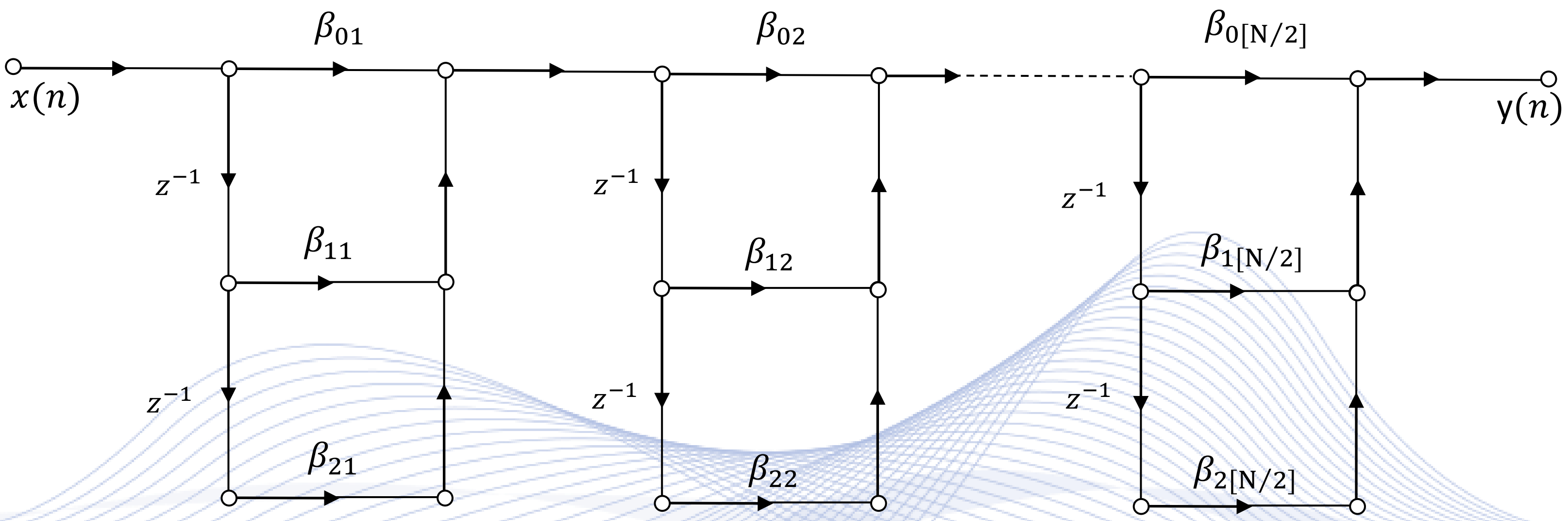
Digital Filter Structures : FIR

Cascade Filter Structure



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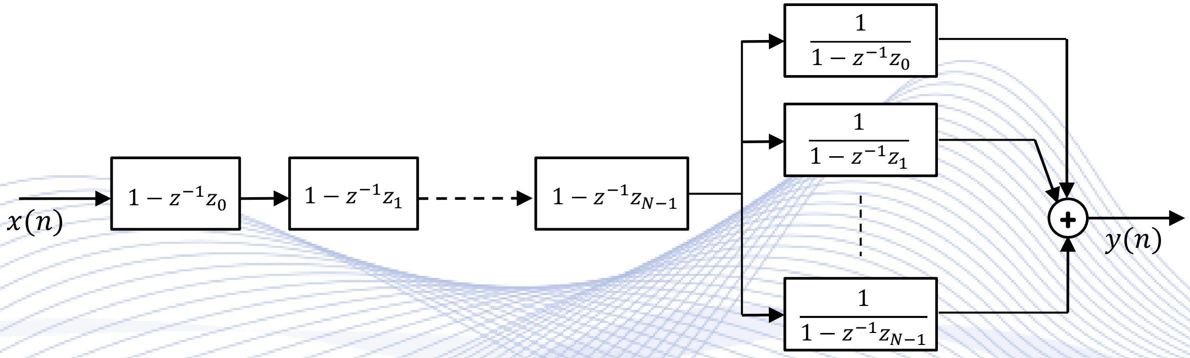
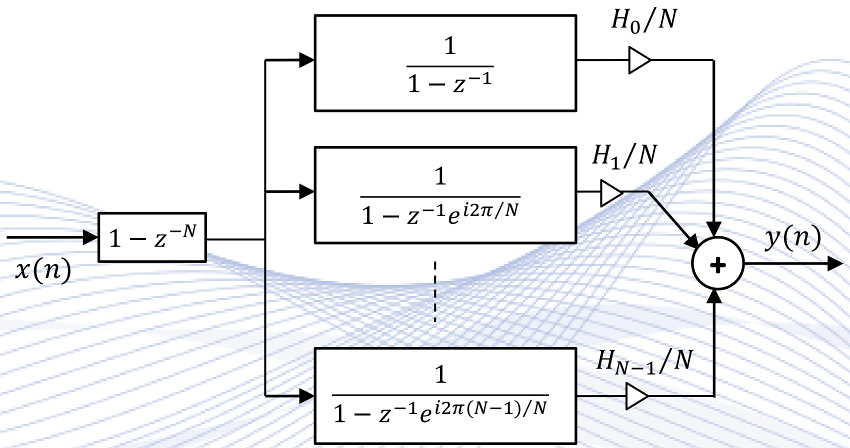
Digital Filter Structures : FIR

Lagrange Filter Structure



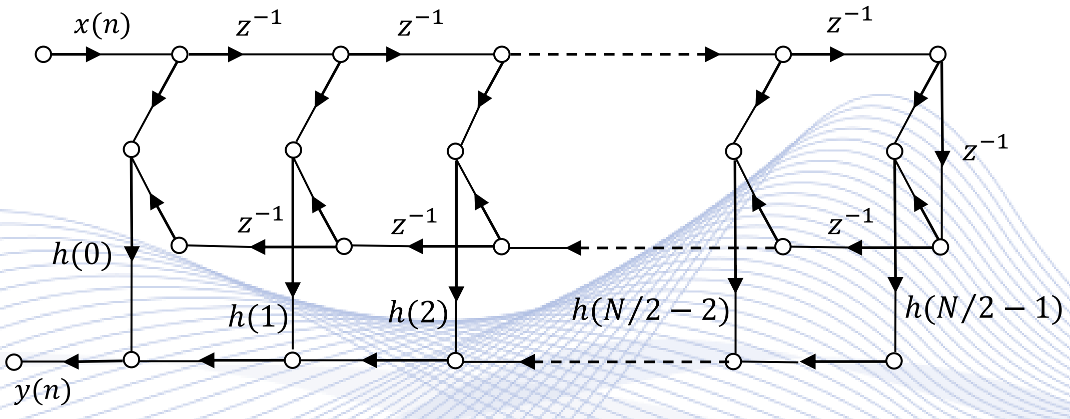
Digital Filter Structures : FIR

Frequency Sampling Structure



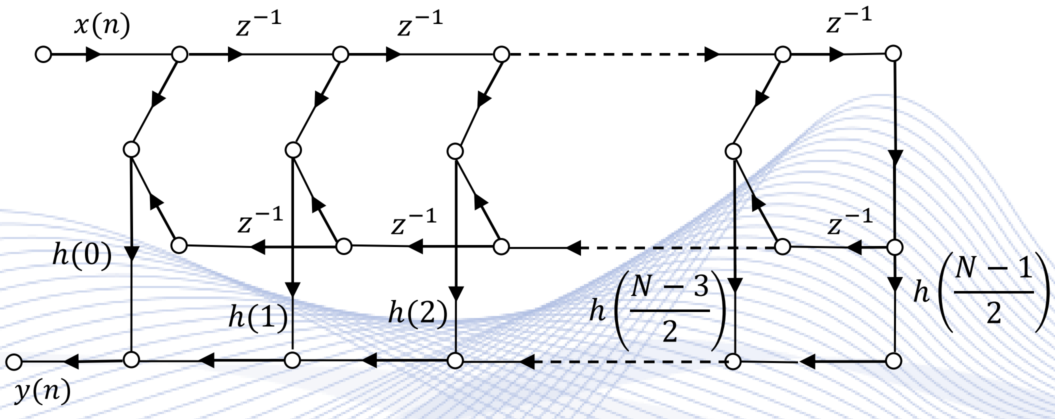
Digital Filter Structures : FIR

Linear Phase Even Structure



Digital Filter Structures : FIR

Linear Phase Odd Structure



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Q & A

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