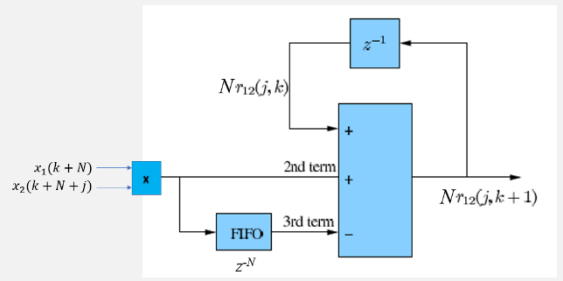
Examples of Quiz 5 question

Questions are related to materials of lectures 10 and 11

* Use the overlap-save method to filter u[n] = (0 1 0 3 1 4 0 2 0 1 0 4 0 1 ...) with the filter, whose impulse response h[n] is [1 2], i.e., $H(z) = 1 + 2z^{-1}$. Use the section length = 4. Showing the processing of three consecutive sections is enough. You may compute the cyclic convolutions in the time domain. Reminder: section overlap in overlap-save method is the filter length minus one.

* What is the purpose of zero padding in application of the frequency domain approach to filtering?

* To what purpose one can use the computational structure shown on the right?



* What is the so-called butterfly operation in Fast Fourier Transform implementations?

* Consider implementation of 4-point DFT as a matrix-vector multiplication. Provide the matrix used for this operation and analyze how many multiplication and addition operations are needed in the implementation. Assume in your analysis that the input vector contains complex values.

Reminder: the rotation operator is $w = e^{-j2\pi/N}$ and matrix elements have form w^{mn}.

* Explain following concepts related to Fast Fourier transform:

(a) radix 2

(b) decimation in time

* Define computation of 2-point and 4-point DFT using matrices and vectors. Provide also corresponding formulae for computing the inverse DFT (IDFT).

* Draw a butterfly diagram of the computation of 8-point decimation-in-time FFT. Estimate the number of additions and subtractions required by the structure.

* Explain when frequency domain approach to FIR filtering provides computational advantage when compared to filtering in time domain.

* Explain (with figures) the principle of complex-modulated filter bank.

* Related to filter banks, an equation of the form $\mathbf{h}^{(m)}(z) = \mathbf{W}_M^* \mathbf{h}^{(p)}(z)$ was discussed in Lecture 11. Explain what the components $\mathbf{h}^{(m)}(z)$, $\mathbf{h}^{(p)}(z)$, and $\mathbf{W}_M^*$ are in this equation, and why the equation is important.

* The prototype filter is defined as $X(z) = 1 + 2z^{-1} + z^{-2}$. Provide all four complex modulations of it for the factor $M = 4$ (that is, the rotation operator $e^{-j\pi/2}$).