Multirate Signal Processing

Seminar 5

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Paula Ajtai
(carmen-paula.ajtai@tu-ilmenau.de)

Homework assignment

To be presented on: 07.07. or 14.07.

Task 1

Setting 1:

a) Take a DCT type 4, and determine the equivalent impulse responses for the analysis and the synthesis. The DCT4 transform matrix is defined as:

$$T_{n,k} = \sqrt{\frac{2}{N}} \cos\left(\frac{\pi}{N}(n+0.5)(k+0.5)\right)$$

b) Use a 8 band DCT (8x8 transform matrix).

c) Plot the frequency responses of the resulting analysis and synthesis filters.

d) Test this filter bank with the audio signal. Do you have perfect reconstruction?

Homework assignment

Task 1

Setting 2:

a) On the analysis side, after subband decomposition keep only the first two or three subbands, set the others to zero.

b) The process on the synthesis side does not change.

c) Use the audio signal to test your DCT filter bank

d) How does the reconstructed signal sound in comparison to the original?

Homework assignment

Task 2

a) Efficiently implement an MDCT analysis and a synthesis filter bank, using the polyphase implementation with the polyphase matrices $\boldsymbol{H}(z)$ and $\boldsymbol{G}(z)$, as described in the lecture, with N=8 subbands and a **sine window** of length 16. (See Fig. 1 in the next slide)

b) Implement Setting 1 and 2 from Task 1

c) Test your filter bank with the audio signal

Homework assignment

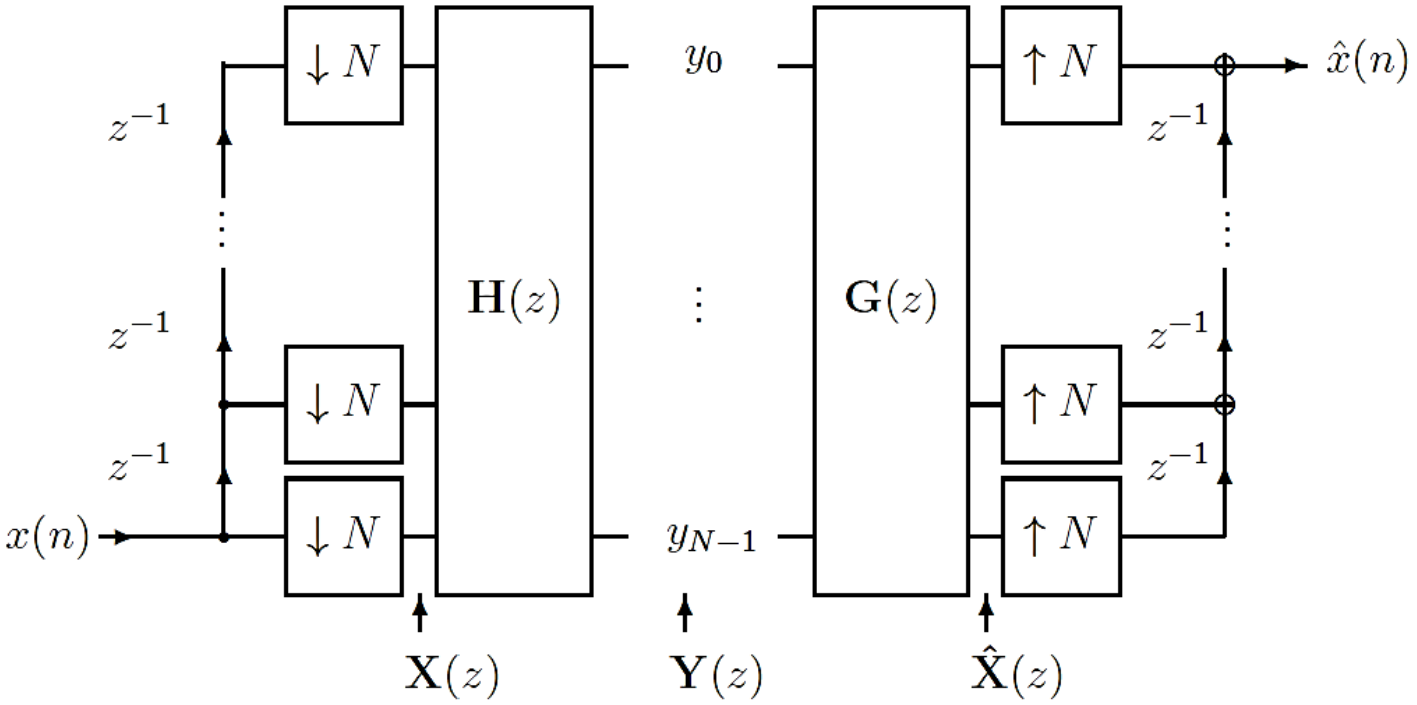

Figure 1: Polyphase representation of an N band filter bank with critical sampling. Observe that z^{-1} always means a delay by 1 sample, independent of the sampling rate.

Homework assignment

Task 3

What is the inverse $H^{-1}(z)$ of the following polyphase matrix? **Use paper and a pen.** This task should be completed without Matlab help (you can use Matlab to check your result).

$$H(z) = \begin{bmatrix} 1z^{-1} & 2 \\ 3z^{-1} & 4 \end{bmatrix}$$