Multirate Signal Processing

Seminar 4
09.06. & 16.06.2016

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

Homework assignment

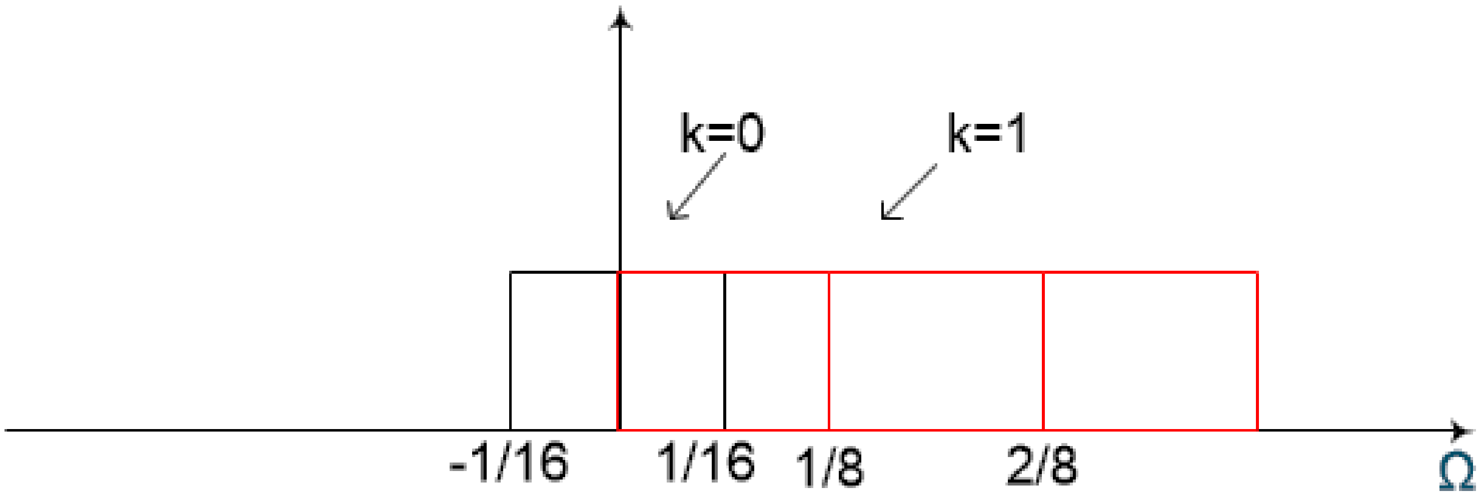
To be presented on: 23.06. or 30.06.

Task 1

a) Design a bandpass filter using modulation, for an 8 band uniform filter bank.
   i. Start with a low pass filter, which you can design using the window method.
   ii. Design this low pass filter such that its pass band goes up to 1/16th of the Nyquist frequency.

b) Then use modulation such that we obtain all the 8 subbands (the subband numbers should start at 0 and go up to 7).

Homework assignment



The band pass filters should be such that all subbands have the same bandwidth, meaning the first should go from 0 to 1/8, the next from 1/8th to 2/8th, and so on.

Homework assignment

Note: The modulation can also be conducted by multiplication with a cosine function instead of a complex valued exponential function. Use

$$\Psi(n) = \cos\left(\frac{\pi}{8}(k + 0.5)n\right)$$

as the modulating function, for subband k=0,...,7, with n as the time index.

Homework assignment

c) Plot the frequency responses of the resulting filters (magnitude range about 0 to -80 dB, normalize it such that 0 dB is the maximum value).

d) Use a signal to test this filter bank. Filter the signal and plot the resulting subband signals in the frequency domain.

Homework assignment

Task 2

a) Implement an FFT filter bank.

   i. Use the same time signal (like an audio signal with a lenght > 1000 samples).

   ii. Divide it into blocks (size 8), and then apply the FFT to each block. This way you get a time/frequency representation, with subbands, like with the filter bank view.

b) Plot the resulting subband signals. Also plot the frequency response of each equivalent FFT filter.

Homework assignment

c) Then apply the inverse FFT to obtain the reconstructed signal. Compare it with the original signal.

Task 3

Compare the two filter banks.