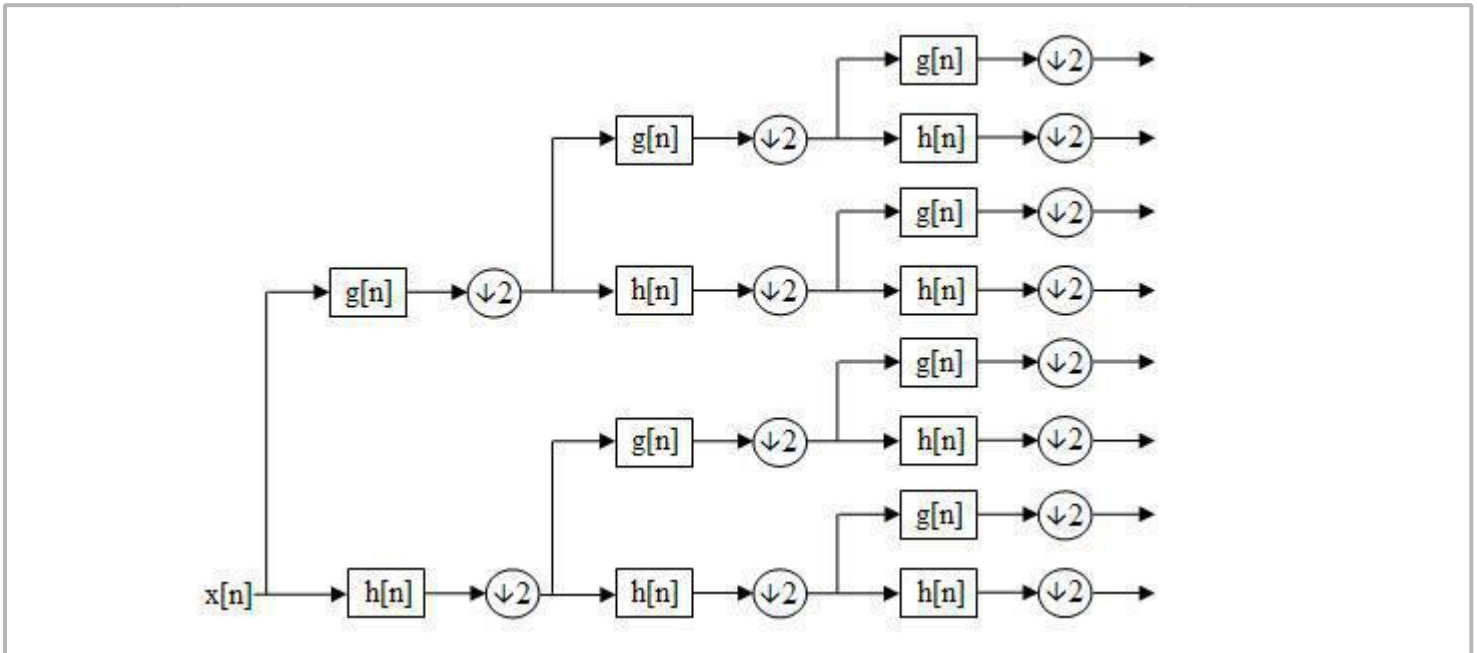# Discrete 1-D wavelet packet decomposition

The MatDeck function ,wavepacketd(), performs wavelet packet decomposition using wavelet filters which are specified by the user. The wavelet packet decomposition is a generalization of the wavelet decomposition that offers a richer signal analysis. The input arguments of the function are: input signal which can be a row vector or a column vector, integer level value, and string which specifies which type of wavelet filter is used. Wavelet packet decomposition results in a filter bank, which is known also as Optimal Subband Tree Structuring, displayed in the following figure for the case when the level of decomposition reaches three.

The wavelet packet decomposition is performed by filtering the input signal at certain levels by using a low-pass filter denoted as g[n] producing the approximation coefficients at a given level, and a high pass filter denoted as h[n] producing the detail coefficients. After that, the coefficients are downsampled by two and fed to the next level. At the next level the procedure is repeated on both the detail and approximation coefficients. The function, wavepacketd(), returns the detail and approximation coefficients of the last level. These coefficients are combined in a special matrix which has 2^n columns where n is the decomposition level . The function also returns the bookkeeping vector which contains the number of coefficients per level, including the input signal. The number of coefficients is necessary for the appropriate reconstruction. The next example shows how the function is used on a simple signal.

$$\text{testS} := \begin{bmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 6 \end{bmatrix}$$

$$\text{level} := 3$$

$$\text{wname} := \text{"db2"}$$

$$\text{TSw} := \text{wavepacketd}(\text{testS} , \text{level} , \text{wname})$$

$$\text{TSw} = \begin{bmatrix} \begin{bmatrix} -0.338 & -1.263 & -0.271 & -1.010 & -0.021 & -0.077 & -0.109 \\ 2.105 & 1.480 & 0.547 & 3.889 & 0.180 & 0.367 & 0.873 \\ 16.264 & -4.358 & -1.888 & 0.506 & -1.928 & 0.516 & 1.392 \end{bmatrix} \\ \begin{bmatrix} 10 & 6 & 4 & 3 \end{bmatrix} \end{bmatrix}$$

Signal reconstruction

The signal is reconstructed by using the wavepacketr() function. The arguments of the filter are vector structure obtained by the packet decomposition and the wavelet name which is used for decomposition.

$$\text{testSr} := \text{wavepacketr}(\text{TSw}, \text{wname})$$

$$\text{testSr}^T = \begin{bmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 6 \end{bmatrix}$$

Therefore, we can say that we have the perfect reconstruction.