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Lecture 3: Lattice Structures

A lattice filter is an example of an all-pass filter typically used the analysis and synthesis of speech signals.

All-zero lattice structure

An ***all-zero*** lattice models an FIR system.

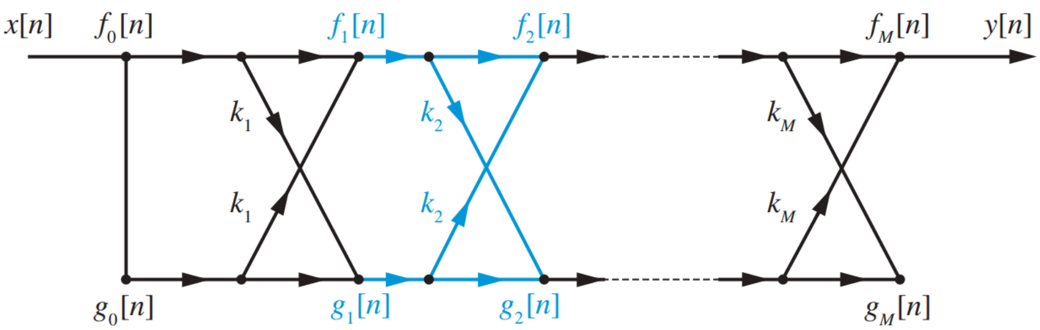

Figure 9.23 An Mth-order all-zero lattice structure.

Each section has two inputs ($f_{m-1}[n]$ and $g_{m-1}[n-1]$) and two outputs $(f_m[n], g_m[n])$.

The *m*'th section can be computed as follows:

$$f_m[n] = f_{m-1}[n] + k_m g_{m-1}[n-1], \quad m = 1, 2, \ldots, M \tag{9.55a}$$

$$g_m[n] = k_m f_{m-1}[n] + g_{m-1}[n-1]. \quad m = 1, 2, \ldots, M \tag{9.55b}$$

The overall system input and output are given by:

$$x[n] = f_0[n] = g_0[n], \tag{9.56a}$$

$$y[n] = f_M[n]. \tag{9.56b}$$

In general, the outputs of the *m*th section correspond to two FIR filters with the same coefficients but in reverse order:

$$f_m[n] = \sum_{i=0}^{m} a_i^{(m)} x[n-i], \quad m = 1, 2, \ldots, M \tag{9.64a}$$

$$g_m[n] = \sum_{i=0}^{m} a_{m-i}^{(m)} x[n-i]. \quad m = 1, 2, \ldots, M \tag{9.64b}$$

The system functions of these all-zero FIR filters are given by:

$$A_m(z) \triangleq \frac{F_m(z)}{F_0(z)} = \sum_{i=0}^{m} a_i^{(m)} z^{-i}, \quad a_0^{(0)} = 1 \tag{9.65a}$$

$$B_m(z) \triangleq \frac{G_m(z)}{G_0(z)} = \sum_{i=0}^{m} a_{m-i}^{(m)} z^{-i} \triangleq \sum_{i=0}^{m} b_i^{(m)} z^{-i}. \tag{9.65b}$$

Find lattice structure coefficients $k_m, m = 1, 2, \cdots, M$ from impulse response $h[n]$?

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All-pole lattice structure

An ***all-pole*** lattice models an IIR system.

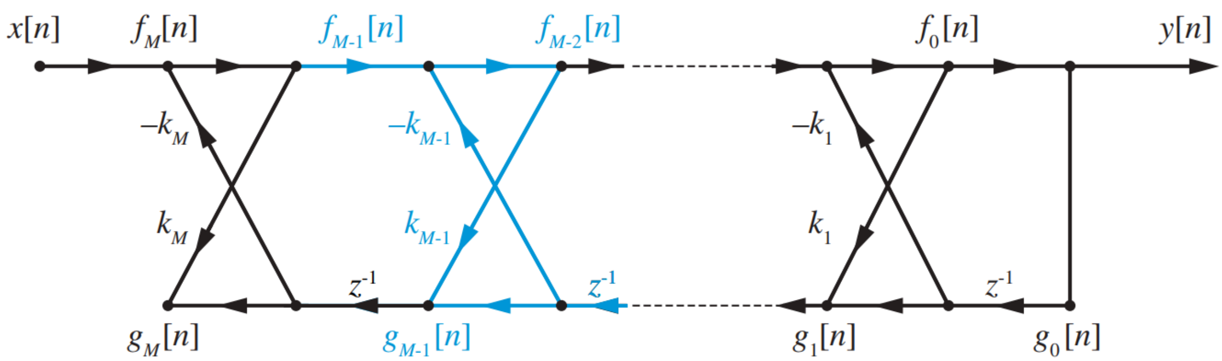

Figure 9.27 An all-pole lattice structure.