ECE-539, Spring 2008
Digital Signal Processing

Example: IIR-QMF filterbank

Consider the QMF solution to alias cancelation that was discussed in the class:

$$F_0(z) = H_0(z)$$
$$H_1(z) = H_0(-z)$$
$$F_1(z) = -H_1(z)$$

This solution produces a transmit component system function of the form:

$$T_r(z) = \frac{1}{2}\left\{H_0^2(z) - H_0^2(-z)\right\}$$

which will produce both amplitude and phase distortion in the output

Suppose $H(z)$ is expressed in terms of its Type-I polyphase components w.r.s.t $M=2$ as:

$$H_0(z) = E_0(z^2) + z^{-1}E_1(z^2)$$
$$H_0(-z) = E_0(z^2) - z^{-1}E_1(z^2)$$

$$\Rightarrow \quad H_0^2(z) - H_0^2(-z) = 4z^{-1}E_0(z^2)E_1(z^2)$$
$$\Rightarrow \quad T_r(z) = 2z^{-1}E_0(z^2)E_1(z^2)$$

$$\Rightarrow \quad |T_r(e^{j\omega})| = |E_o(e^{j2\omega})|\,|E_1(e^{j2\omega})| \cdot 2$$

$\Rightarrow$ If $H_o(z)$ is designed $\ni$ its polyphase components w.r.s.t $M=2$ are all-pass filters then $|T_r(e^{j\omega})|$, i.e, no magnitude distortion

$\Rightarrow$ Power symmetric elliptic filters can be used to design the filter $H_o(z)$ $\ni$ its polyphase components are all-pass.

$\Rightarrow$ Obviously to eliminate distortion we could design $H_o(z)$ $\ni$ $E_1(z) = \dfrac{1}{E_o(z)}$ however, the filters would have to be IIR