Notch filter design

IIR Notch filter

Given by this transfer function

$$H(z) = b_0 \frac{1 - (2\cos\omega_0)z^{-1} + z^{-2}}{1 - (2r\cos\omega_0)z^{-1} + r^2 z^{-2}}$$

where r describes how much of frequency around ω_0 is going to be away ($r \to 1$ give more selective notch filter)

ω_0 is frequency to get rid of $\omega_0 = 2\pi\frac{f}{f_s}$

Structure

$\Rightarrow$

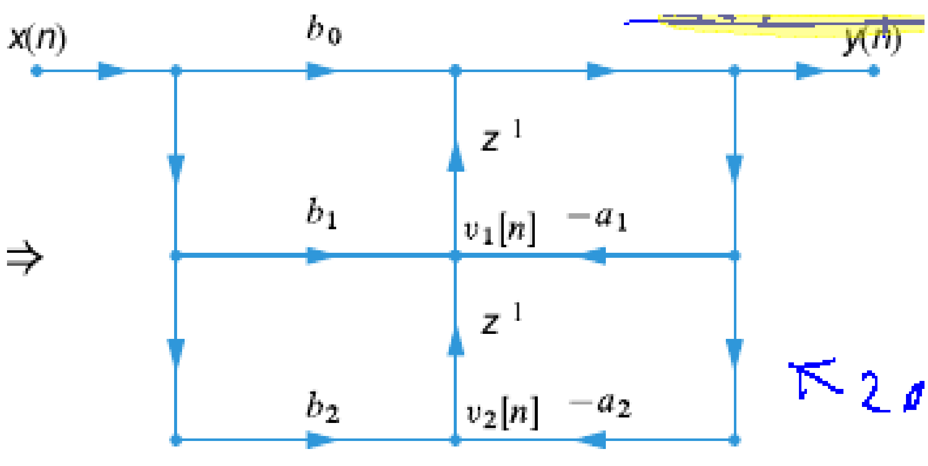

Figure 1: IIR transposed direct 2

Filter will be realized with most used IIR transposed direct form 2 (zero first)

given by

$$y[n] = v_1[n-1] + b_0 x[n]$$

$$v_1[n] = v_2[n-1] - a_1 y[n] + b_1 x[n]$$

$$v_2[n] = b_2 x[n] - a_2 y[n]$$

for a 2 order IIR filter described by

$$H(z) = \frac{b_0 + b_1 z^{-1} + b_2 z^{-2}}{1 + a_1 z^{-1} + a_2 z^{-2}}$$

So for our notch filter: * $a_1 = -2 \cdot r \cos 2\pi \frac{f}{f_s}$ * $a_2 = r^2$ * $b_0 = b_2 = 1$ (gain 1) * $b_1 = -2 \cdot \cos 2\pi \frac{f}{f_s}$

Psuedo Code

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1. define static variables - prev_v1, prev_v2 = 0
2. compute constant coefficients based on sampling freq, target freq, and degree of selectio
3. compute yn = prev_v1 + xn
4. compute v1 = prev_v2 - a_1*yn + b_1*xn
5. compute v2 = xn - a_2*yn
6. update static variables
7. return yn
```