

Zero-Phase Filtering

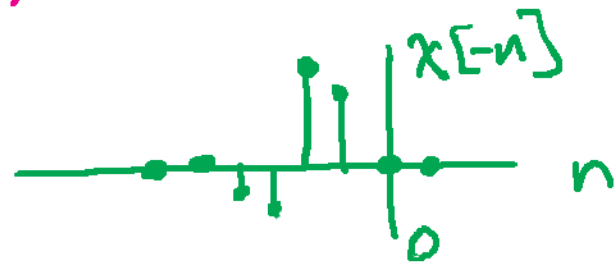
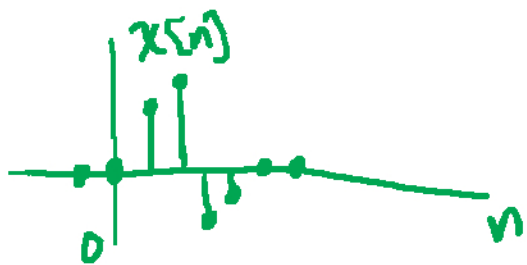
Zero phase: no phase distortion, not even time / delay of linear phase

Noncausal filter - post-processing of stored data
blurs transients forwards and backwards in time

MATLAB command "filtfilt"

Uses time-reversal property of DTFT

If $x[n] \xleftrightarrow{\text{DTFT}} X(e^{j\omega})$, then $x[-n] \xleftrightarrow{\text{DTFT}} X^*(e^{j\omega})$



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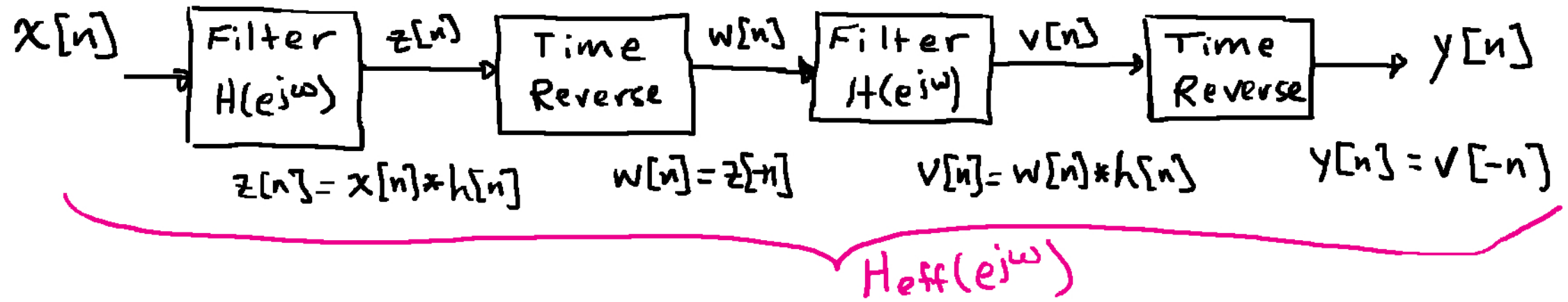
Uses time-reversal property of DTFT

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Filter data forwards, then filter backwards in time

Block diagram

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$$1) z(e^{j\omega}) = H(e^{j\omega})X(e^{j\omega})$$

$$2) W(e^{j\omega}) = z^*(e^{j\omega}) = H^*(e^{j\omega})X^*(e^{j\omega})$$

$$3) V(e^{j\omega}) = H(e^{j\omega})W(e^{j\omega}) = |H(e^{j\omega})|^2 X^*(e^{j\omega})$$

$$4) Y(e^{j\omega}) = V^*(e^{j\omega}) = |H(e^{j\omega})|^2 X(e^{j\omega})$$

$$H_{eff}(e^{j\omega}) = |H(e^{j\omega})|^2$$

Issues -

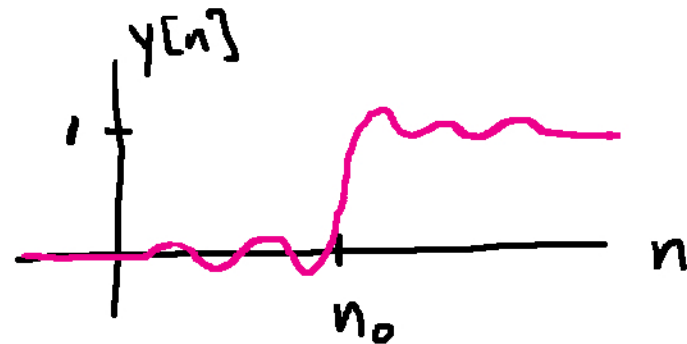
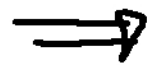
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- 1) Entire input data sequence $x[n]$ must be available
- 2) Translate specifications on $H_{\text{eff}}(e^{j\omega})$ to $H(e^{j\omega})$

$$H_{\text{eff}}(e^{j\omega}) = |H(e^{j\omega})|^2$$

Example: 60 dB stopband attenuation for $H_{\text{eff}}(e^{j\omega})$
 \Rightarrow design $H(e^{j\omega})$ to have 30 dB attenuation

- 3) Causality is lost



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