DSP Finite Impulse Response Filters 02/06/2023. Monday.

(ppt. slide 5)

Purpose of FIR filter? (5-3)

⇒ Noise Removal

get rid of frequencies we don't want (noise)

usually bandpass filtering

⇒ Spectral Analysis

used in interpolation (called FIR interpolation, filterbanks)

separate low frequencies and high frequencies, or combine frequencies

⇒ Spectral shaping

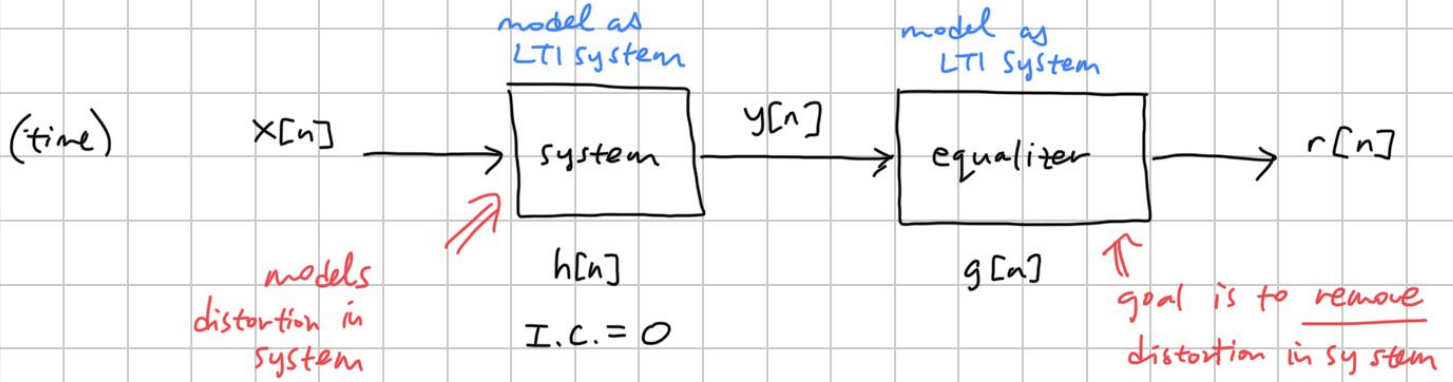
data conversion

equalization / pre-distortion

carrier frequency / phase recovery

timing recovery

example of pre-distortion: goal ⇒ get r[n] = x[n]



$$Y_{freq}(\omega) = H_{freq}(\omega) \cdot X_{freq}(\omega)$$

$$R_{freq}(\omega) = G_{freq}(\omega) \cdot Y_{freq}(\omega)$$

$$= G_{freq}(\omega) \cdot [H_{freq}(\omega) \cdot X_{freq}(\omega)]$$

$$= G_{freq}(\omega) \cdot H_{freq}(\omega) \cdot X_{freq}(\omega)$$

goal: to pass all frequencies

$$\Rightarrow G_{freq}(\omega) = \frac{1}{H_{freq}(\omega)}$$

☆ goal: to remove effects of distortion ($h[n]$)

☆ but what happens if...

① $H_{freq}(\omega) = 0$?

② $|H_{freq}(\omega)| = 0$?

FIR Filter ⇒ Same as a tapped delay line (for implementation)
(Slide 5-5)

we want it to be LTI: thus all I.C. = 0.

what are I.C.? we have M-1 delay blocks

⇒ we have M-1 I.C.

$x[-1], x[-2], \ldots x[-(M-1)] = 0$

→ consider @ n=0 (time=0) (first terms)

☆ h[...] = coefficients that scale the amplitude of input signal x[n]

$y[0] = h[0]x[0] + h[1]x[-1] + h[2]x[-2] + \cdots + h[M-1]x[-(M-1)]$

- $y[0]$: current OUTPUT
- $h[0]x[0]$: current INPUT
- $h[1]x[-1]$: I.C.
- $h[2]x[-2]$: I.C.
- $\cdots$: I.C.
- $h[M-1]x[-(M-1)]$: I.C.

Computation Complexity:

how many multiplications? ⇒ you have M coefficients ⇒ M multiplications

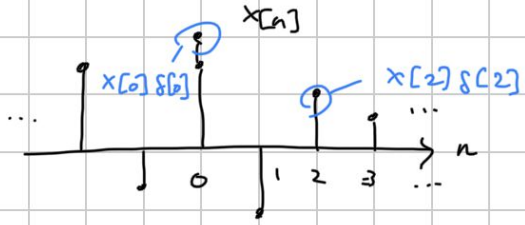
how many additions? ⇒ 2 cases ① accumulator ⇒ M additions

② just add ⇒ M-1 additions

Derive D.T. Convolution of FIR Filter (Slide 5-6)

you can take infinitely long signal, and decompose it into countably infinite parts.

example:



break @ 11:13 AM.

return @ 11:19 AM.

LTI system (Slide 5-7)

characterized entirely by impulse response h[n]

⇒ you know everything about system based on only h[n]

you can build an LTI system using convolution.

MATLAB demonstration @ 11:23 AM