Reconstruction using First order hold

By

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Interpolation using First order hold

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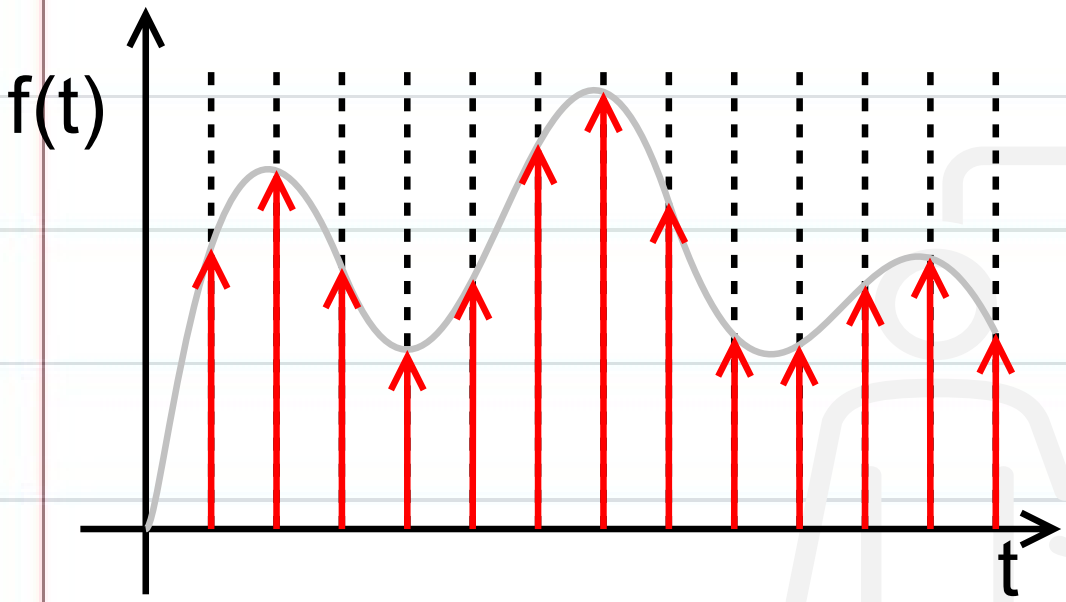

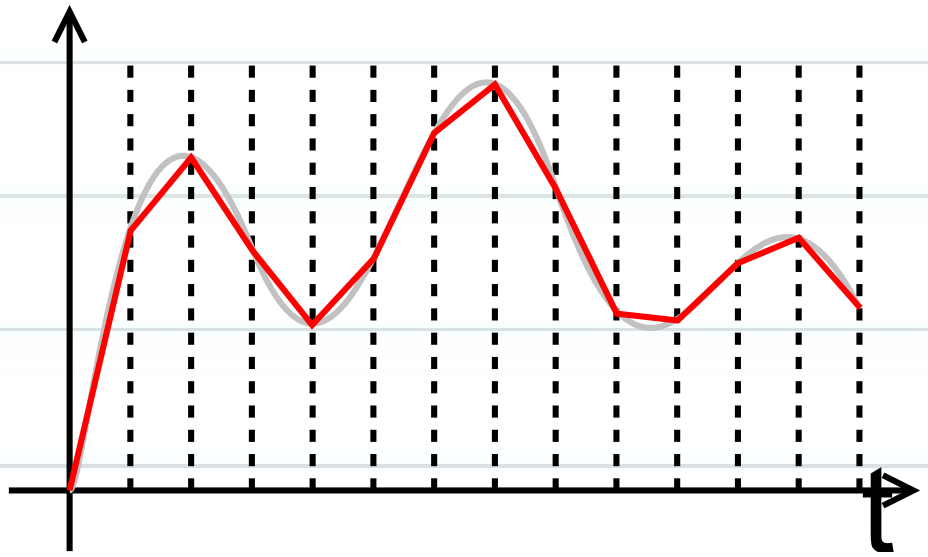

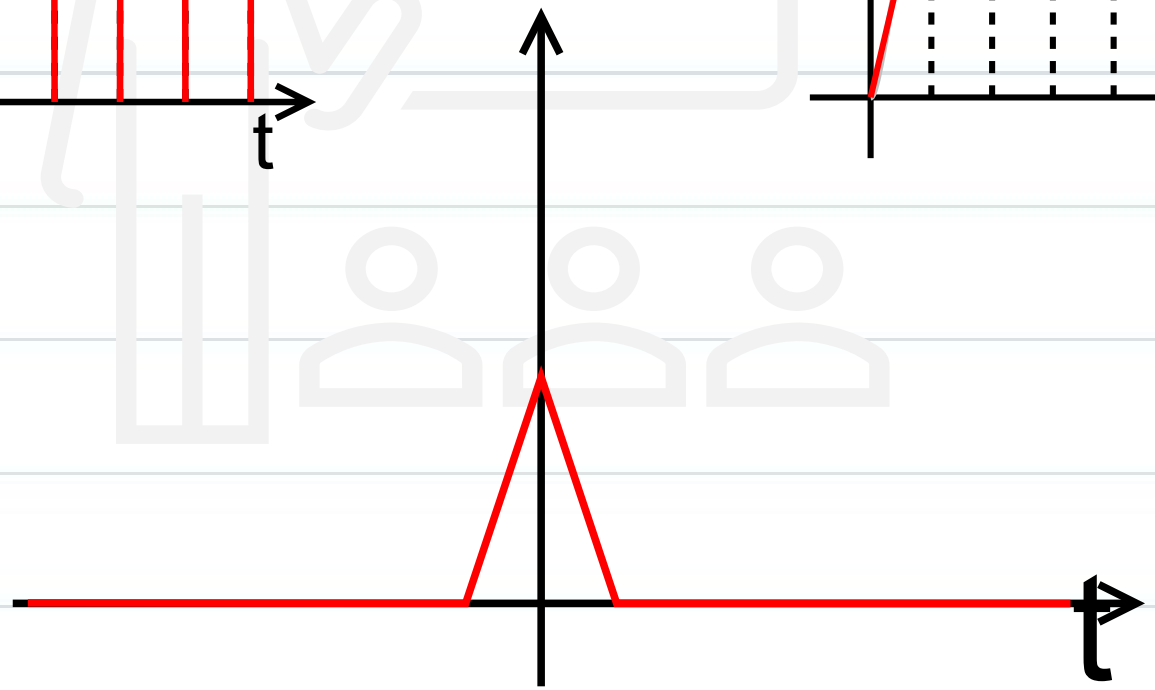

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First-order hold is the hypothetical filter or LTI system that converts the ideally sampled signal

$$x_s(t) = x(t)\,T \sum_{n=-\infty}^{\infty} \delta(t - nT)$$

$$= T \sum_{n=-\infty}^{\infty} x(nT)\delta(t - nT)$$

to the piecewise linear signal

$$x_{\mathrm{FOH}}(t) = \sum_{n=-\infty}^{\infty} x(nT)\mathrm{tri}\left(\frac{t - nT}{T}\right)$$

resulting in an effective impulse response of

$$h_{\mathrm{FOH}}(t) = \frac{1}{T}\mathrm{tri}\left(\frac{t}{T}\right) = \begin{cases} \frac{1}{T}\left(1 - \frac{|t|}{T}\right) & \text{if } |t| < T \\ 0 & \text{otherwise} \end{cases}$$

where $\mathrm{tri}(x)$ is the triangular function.

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The effective frequency response is the continuous Fourier transform of the impulse response.

$$
\begin{aligned}
H_{\mathrm{FOH}}(f) &= \mathcal{F}\{h_{\mathrm{FOH}}(t)\} \\
&= \left(\frac{e^{i\pi fT} - e^{-i\pi fT}}{i2\pi fT}\right)^2 \\
&= \operatorname{sinc}^2(fT)
\end{aligned}
$$

where $\operatorname{sinc}(x) = \dfrac{\sin(\pi x)}{\pi x}$ is the normalized sinc function.

The Laplace transform transfer function of FOH is found by substituting $s = i\,2\,\pi\,f$:

$$
\begin{aligned}
H_{\mathrm{FOH}}(s) &= \mathcal{L}\{h_{\mathrm{FOH}}(t)\} \\
&= \left(\frac{e^{sT/2} - e^{-sT/2}}{sT}\right)^2
\end{aligned}
$$

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Thank you for your attention!