Sampling theory diagrams

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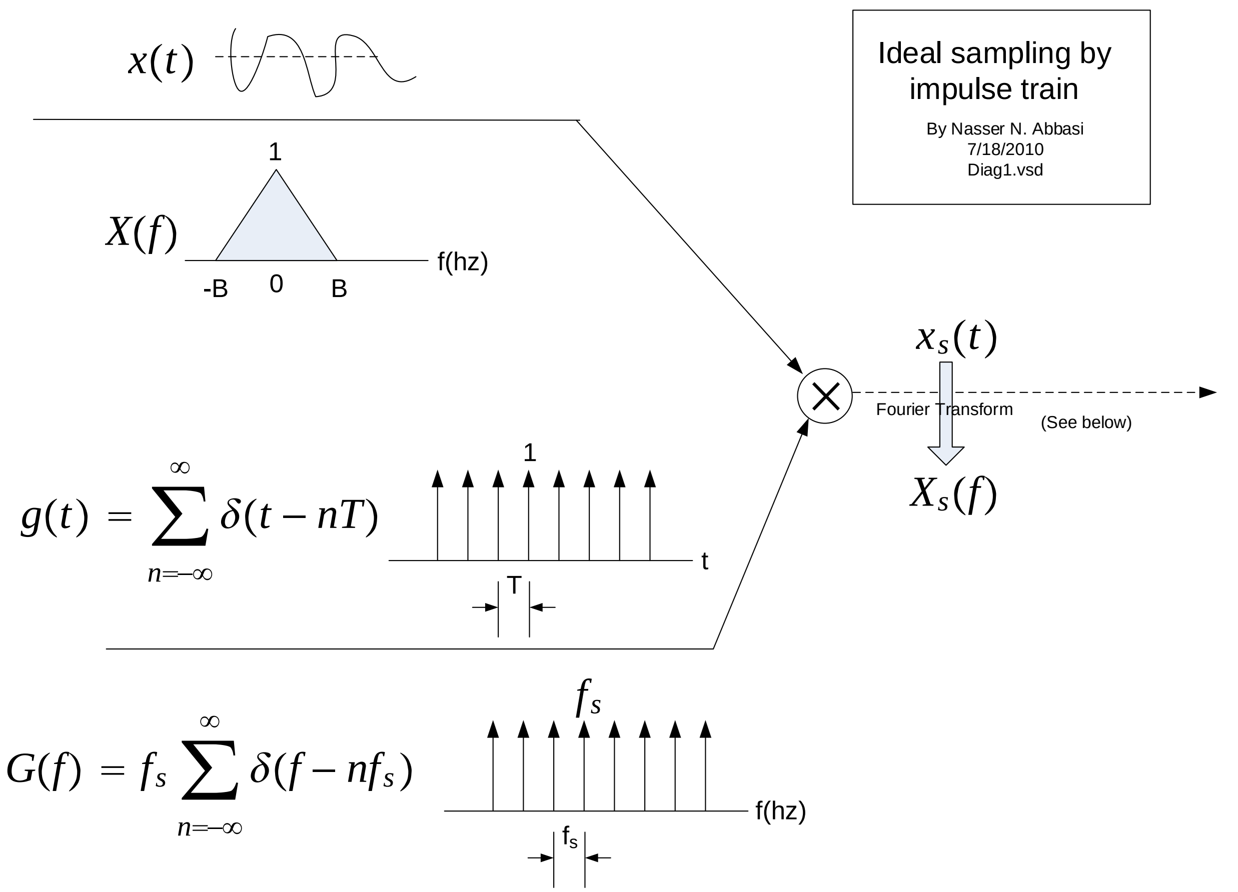
sometime in 2011 page compiled on June 29, 2015 at 10:29pm

These two diagrams illustrate the sampling theory. The first is for ideal sampling, where the sampling train is made up of impulses.

The second diagram is when using what is called practical sampling, where the sampling tain is made up of impulses of some width (small rectangles).

In these diagrams, time domain and the spectrum are shown before and after sampling.

1 Ideal sampling



Alternative way to write the sampled signal x(t)

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

Fourier series approx

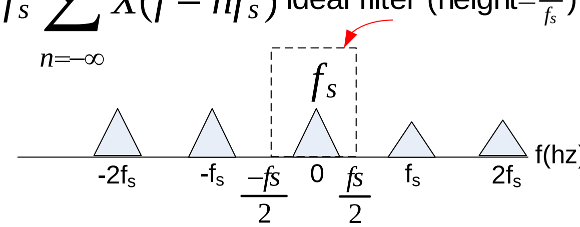
$$x_s(t) \approx x(t)\left(f_s \sum_{n=-\infty}^{\infty} e^{j\frac{2\pi}{T}nt} \right)$$

Fourier series approximation of the pulse train

Fourier Transform

$$X_s(f) = X(f) \circledast \underbrace{\left(f_s \sum_{n=-\infty}^{\infty} \delta(f - nf_s) \right)}_{G(f)} = f_s \sum_{n=-\infty}^{\infty} X(f - nf_s)$$

ideal filter (height=$\frac{1}{f_s}$)



2 Practical sampling