Etapas esenciales en DSP
DSP, aspectos de implementación

Ing. Rodrigo González
rodralez@frm.utn.edu.ar

Técnicas Digitales III

Universidad Tecnológica Nacional,
Facultad Regional Mendoza.

Resumen

Sistema DSP

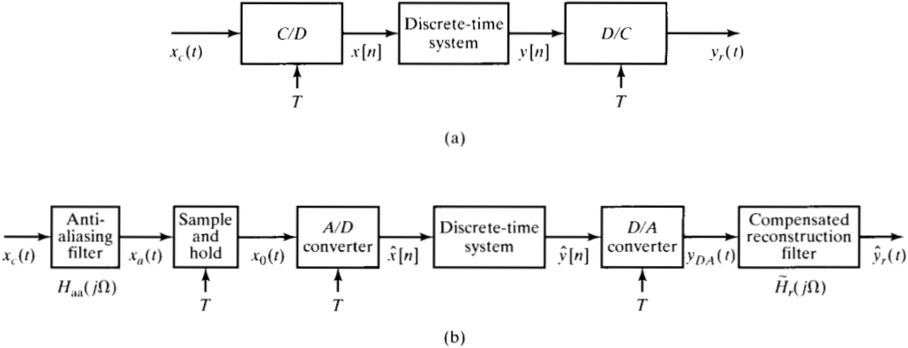

Figure 4.41 (a) Discrete-time filtering of continuous-time signals. (b) Digital processing of analog signals.

Filtro antialiasing, motivación

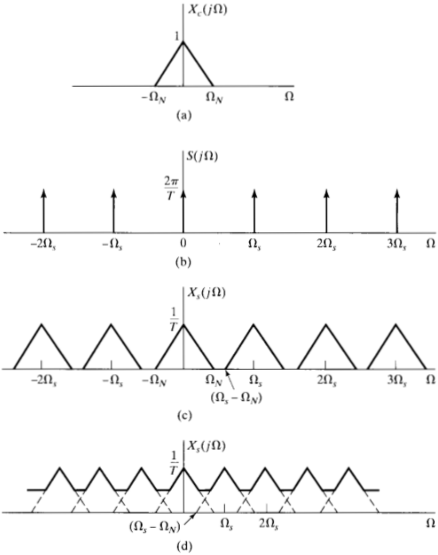

Figure 4.3 Effect in the frequency domain of sampling in the time domain. (a) Spectrum of the original signal. (b) Spectrum of the sampling function. (c) Spectrum of the sampled signal with $\Omega_s > 2\Omega_N$. (d) Spectrum of the sampled signal with $\Omega_s < 2\Omega_N$.

Filtro antialiasing

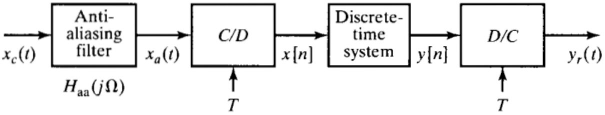

Figure 4.42 Use of prefiltering to avoid aliasing.

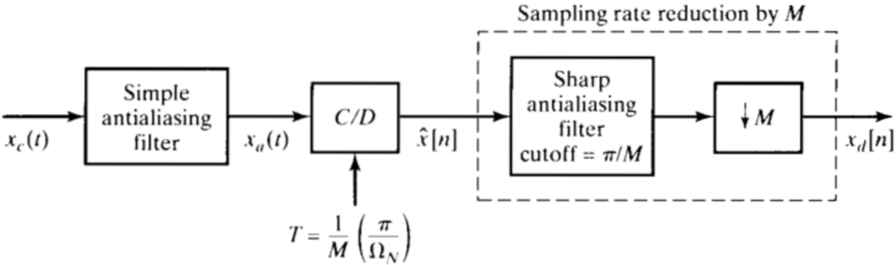

Figure 4.43 Using oversampled A/D conversion to simplify a continuous-time antialiasing filter.

Filtro antialiasing, espectro Oversampling

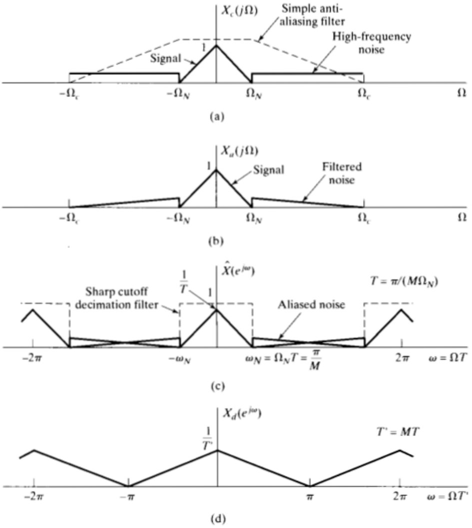

Figure 4.44 Use of oversampling followed by decimation in C/D conversion.

Figure 4.44 Use of oversampling followed by decimation in C/D conversion.

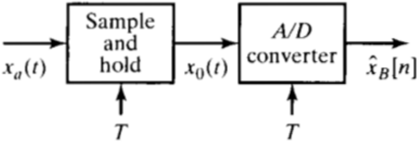

Figure 4.45 Physical configuration for analog-to-digital conversion.

ADC, Sample and hold

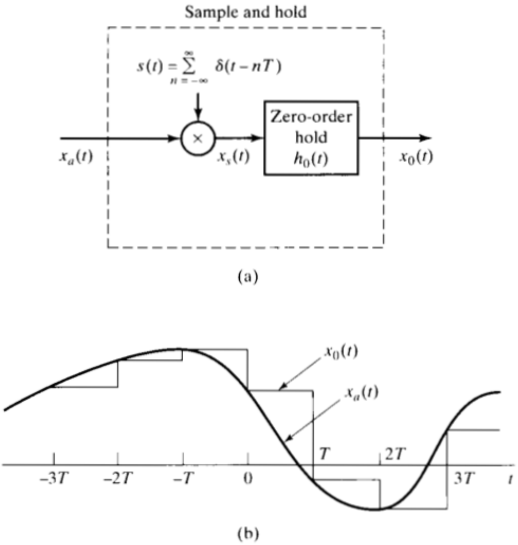

Figure 4.46 (a) Representation of an ideal sample-and-hold.
(b) Representative input and output signals for the sample-and-hold.

Cuantizador

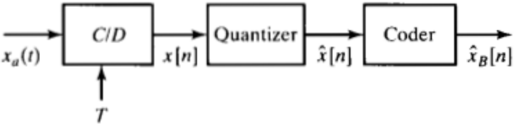

Figure 4.47 Conceptual representation of the system in Figure 4.45.

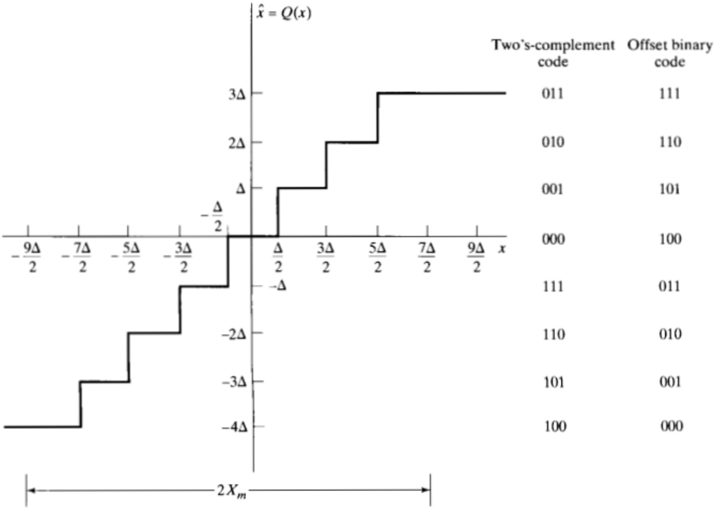

Figure 4.48 Typical quantizer for A/D conversion.

Cuantizador, modelado del error

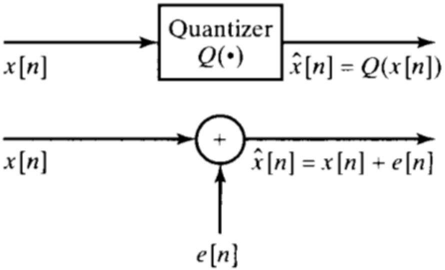

Figure 4.50 Additive noise model for quantizer.

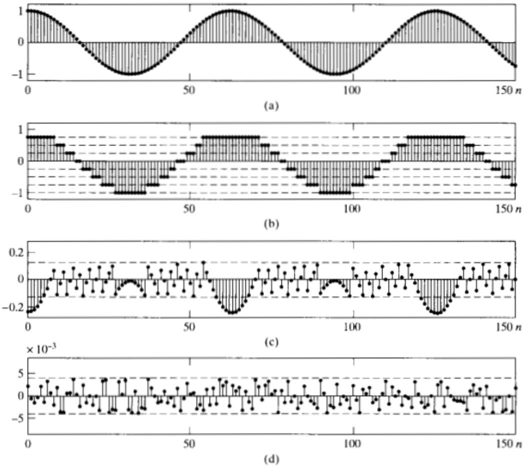

Figure 4.51 Example of quantization noise. (a) Unquantized samples of the signal $x[n] = 0.99\cos(n/10)$. (b) Quantized samples of the cosine waveform in part (a) with a 3-bit quantizer. (c) Quantization error sequence for 3-bit quantization of the signal in (a). (d) Quantization error sequence for 8-bit quantization of the signal in (a).

Cuantizador, función de densidad de probabilidad del error

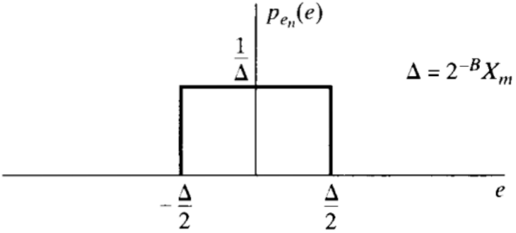

Figure 4.52 Probability density function of quantization error for a rounding quantizer such as that of Figure 4.48.

Cuantizador, ecuaciones

$$\sigma_e^2 = \int_{-\Delta/2}^{\Delta/2} e^2 \frac{1}{\Delta} de = \frac{\Delta^2}{12}. \tag{4.122}$$

For a $(B+1)$-bit quantizer with full-scale value X_m, the noise variance, or power, is

$$\sigma_e^2 = \frac{2^{-2B} X_m^2}{12}. \tag{4.123}$$

A common measure of the amount of degradation of a signal by additive noise is the signal-to-noise ratio, defined as the ratio of signal variance (power) to noise variance. Expressed in decibels (dB), the signal-to-noise ratio of a $(B+1)$-bit quantizer is

$$\begin{aligned} \text{SNR} &= 10 \log_{10}\left(\frac{\sigma_x^2}{\sigma_e^2}\right) = 10 \log_{10}\left(\frac{12 \cdot 2^{2B} \sigma_x^2}{X_m^2}\right) \\ &= 6.02B + 10.8 - 20 \log_{10}\left(\frac{X_m}{\sigma_x}\right). \end{aligned} \tag{4.124}$$

From Eq. (4.124), we see that the signal-to-noise ratio increases approximately 6 dB for each bit added to the word length of the quantized samples, i.e., for each doubling of the number of quantization levels. It is particularly instructive to consider the term

$$-20 \log_{10}\left(\frac{X_m}{\sigma_x}\right) \tag{4.125}$$

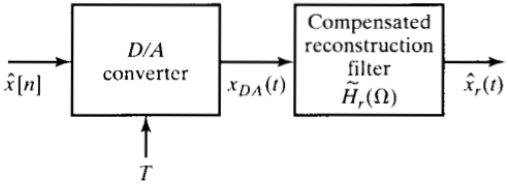

Figure 4.55 Physical configuration for digital-to-analog conversion.

Filtro compensado

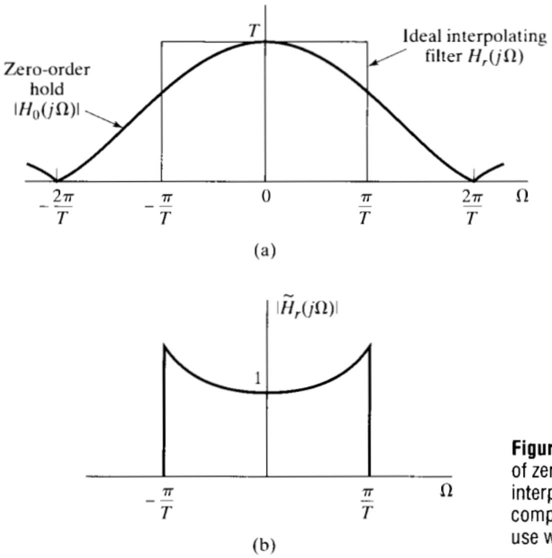

Figure 4.54 (a) Frequency response of zero-order hold compared with ideal interpolating filter. (b) Ideal compensated reconstruction filter for use with a zero-order-hold output.

Bibliografía

- Alan V. Oppenheim and Ronald W. Schafer. *Discrete-time signal processing, 2nd Ed*. Prentice Hall. 1999. Capítulo 4.
- Richard G. Lyons. *Understanding Diginal Signal Processing, 2nd Ed*. Prentice Hill. 2004. Sección 12.3.1.