EE 502 Spring 2003

HW Assignment 2

Assigned: 3 February 2003
Due: 14 February 2003

From the textbook:

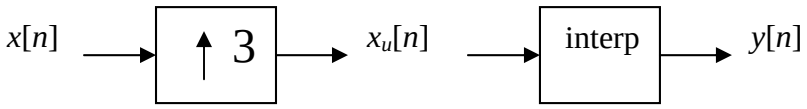
4.3; 4.15; 4.21; 4.22; and 4.60

Simulation Problem

For the signal

$$x[n] = 5\cos\left(\frac{2\pi n}{3}\right) + 2\sin\left(\frac{2\pi n}{5}\right)$$

we need to upsample by a factor of 3. In other words, we need to interpolate two new samples between each of the existing samples in $x[n]$ to create the output signal $y[n]$.



Simulate and compare the following four interpolation methods. For each method, calculate several cycles of the upsampled sequence following any initial transient behavior. Find the *difference sequence* between your interpolation and a "perfect" reconstruction obtained by computing the exact sequence values using the equation for $x[n]$.

Method 1: Zero-order hold interpolation. This means that the current sample from $x[n]$ is simply repeated two times, creating sort of a stair-step output.

Method 2: Linear interpolation. The inserted pair of samples are computed by finding a straight line between adjacent samples of $x[n]$ and determining the interpolated sample values on this line.

Method 3: Sinc function with ±3 oscillations. Use a truncated sin(c)/c function (non-causal) that has three oscillations (4 zero crossings) for positive and negative c, and convolve this finite-length sequence with $x_u[n]$ to interpolate the pairs of samples.

Method 4: Sinc function with ±6 oscillations. Use a truncated sin(c)/c function (non-causal) that has six oscillations (7 zero crossings) for positive and negative c, and convolve this finite-length sequence with $x_u[n]$ to interpolate the pairs of samples.

Prepare a brief write-up explaining your simulation method and documenting your results. Include the maximum and RMS error between each interpolated sequence and the "perfect" sequence. You should also give some consideration to the amount of computation required for each method, as well as some comments on the theoretical foundation for each approach.