Common Pulses Used in Communications

Lab 9, DSP

Objective

The students shall know show of the pulses used in communications and be capable of analyzing their spectrum.

Theoretical aspects

Square pulses are rarely used in communication due to their high frequency content. The Fourier series coefficients of a discrete periodical signal can be computed from one period of the signal with:

Exercises

1. Generate a 100 samples long **rectangular** signal `x` defined as $x[n] = [\underbrace{1, 1, ...1}_{50}, \underbrace{0, 0, ...0}_{50}]$.
   a. Plot the signal in the top half of a figure (use `subplot()`).
   b. Compute the Fourier series coefficients with `fft()` and plot their magnitude in the lower half of the figure. Use the code from the last laboratory to compute the spectrum:

```
% Given a signal x with length N

% Compute the Fourier series coefficients and find their magnitudes and phases
c = fft(x);
m = abs(c);
```

```
phase = angle(c);

% Find the amplitudes of sinusoidal components
m = m(1:(N/2+1));
m(2:N) = 2*m(2:N);

% Frequencies' values = multiples of fundamental 1/N
f = (0:(N/2))*1/N;
```

2. Reconstruct and plot the signal `x` by summing all the sinusoidal components back again.
   - Each component is a cosine with amplitude `m(i)`, frequency `f(i)` and phase `phase(i)`.
   - The DC component of the signal is just like a sinusoidal component with frequency 0 (i.e. constant signal)
   - Full formula is:

$$x[n] = \sum_i m(i) \cos(2\pi f(i) + phase(i))$$

3. Reconstruct and plot the signal `x` as in previous exercise, but keeping only some of the sinusoidal components. Display a figure composed of 5 subfigures, where the signal contains only:
   a. The first 2 components (DC + fundamental)
   b. The first 5 components
   c. The first 10 components
   d. The first 20 components
   e. All the components
4. Repeat exercises 1 and 3 using a 100-long Gaussian pulse (*Hint*: checl Matlab function `gausswin()`. How is the spectrum of the Gaussian pulse compared to a rectangular pulse? Why?
5. Open Matlab's Window Designer tool (`windowDesigner`). Visualize the time-domain and frequency-domain domain aspect of the following window types:
   - rectangular
   - raised cosine
   - gaussian
   - Kaiser
   - Hann

Final questions

1. TBD