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ECE300 Communication Theory
Problem Set VII: Digital Baseband Processing
October 29, 2021

1. Consider a digital communication scheme using 8-PSK, a bit rate of $6Mbps$, digital processing with 16 samples per symbol, and employing $\sqrt{RC}$ pulses with 20% rolloff.

   (a) Compute the symbol rate.

   (b) Compute the sampling rate for the digital processor.

   (c) Compute the bandwidth of the pulses.

2. Here you will use MATLAB to explore pulse design. Take BPSK (symbols ± 1) with symbol rate $R_s = 1Mbps$, $L = 16$ samples per symbol. We want an FIR approximation to a $\sqrt{RC}$ filter with rolloff 30%, that spans 4 symbols.

   In MATLAB, the following will generate the coefficient vector of the FIR filter (i.e., the underlying pulse shape):

   $$p = r\cos design(beta, span, L, 'sqrt');$$

   where here $span = 4$. Let $g[n]$ denote the pulse shape at the output of the matched filter, which is obtained by convolving $p[n]$ with its flip.

   (a) Generate the p vector as above. Let N denote its length. Obtain a stem plot of p (horizontal axis from 0 to $N-1$). Find the index where the peak occurs, say kp_peak. You will note the pulse extends out so that interference comes from indices $kp\_peak \pm L$ and $\pm 2L$.

   (b) Obtain a stem plot of the g vector, as you did for the p vector (careful: it is longer than p!). Let kg_peak denote the index where the peak occurs. The ISI at the output of the matched filter is determined by indices that are offset by $\pm L, \pm 2L, \pm 3L, \pm 4L$ from this peak index. Observe the peak value of g is 1; determine the maximum (magnitude) of any single interferer; and compute the signal-to-interference ratio (SIR) in decibels for this case.

   (c) Use *freqz* to compute $|P(f)|$ and $|G(f)|$, the magnitude spectra of $p[n]$ and $g[n]$, respectively, at 1000 frequency points from 0 to R_s. Plot $|P(f)|$ on a linear scale (horizontal axis in Hertz). Obtain a separate plot in which you show $|G(f)|$, $|G(R_s - f)|$, and $|G(f)| + |G(R_s - f)|$ superimposed (different colors). Then repeat this plot (of the $|G|$ spectra) with the magnitude on a decibel scale; for the case of the decibel scale, set the vertical axis limits so the maximum versus minimum is no more than 30dB.