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EE 5141 Introduction to Wireless and Cellular Communications
February – May 2021

Computer Assignment # 7 (Due date: April 7, 2021)

Honour Code: Add this to your assignment

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Impact of ISI on BER Performance(Differential Detection)

1. The goal of this task is to evaluate BER performance of Differential Detection for DQPSK in channels with ISI. Consider the DQPSK simulator in AWGN developed in Assignment 3. Introduce ISI in the channel as given by
   $r(t) = u(t) + \alpha\, u(t-\tau) + \eta(t)$. Let $\alpha = 0.1$ and $\tau = \frac{T_s}{8}$ (one-eighth of a symbol). Since we are using 8 samples per symbol, justify that the sampled equivalent of this channel is given by
   $r[n] = s[n] + 0.1\, s[n-1] + \eta[n]$
   Downsample the signal to one sample per symbol r_n (based on the optimum sampling point and perform differential detection.
   - $bit\left[b_{n,1}\right] = \{0 \text{ if } Re\left\{r^n\, r^*_{n-1}\right\} > 0 \;\; 1 \text{ if } Re\left\{r_n\, r^*_{n-1}\right\} \le 0$
   - $bit\left[b_{n,0}\right] = \{0 \text{ if } Im\left\{r_n\, r^*_{n-1}\right\} > 0 \;\; 1 \text{ if } Im\left\{r_n\, r^*_{n-1}\right\} \le 0$

   (b) Compute BER for $\frac{E_b}{N_0}$ in the range [0, 10dB] in steps of 2 dB, using 500 bursts for averaging

   (c) Plot BER versus $\frac{E_b}{N_0}$

   (d) Is there any performance difference when compared with a channel without ISI.
2. Repeat the above steps for the following channel
   $r(t) = u(t) + \alpha\, u(t-\tau) + \eta(t)$, where $\alpha = 0.1$ and $\tau = \frac{T_s}{4}, \frac{3T_s}{8}, \frac{T_s}{2}, \frac{3T_s}{4}, T_s$
3. Repeat the above steps for the following channel
   $r(t) = u(t) + \alpha\, u(t-\tau) + \eta(t)$, where $\alpha = 0.2, 0.3, 0.5, and\ 1.0$ and $\tau = \frac{T_s}{8}$

   Based on simulations 1,2,3 write down your observations about the degradations caused by ISI that is not compensated. This points to a coherent receiver can handle ISI, that will be developed in a subsequent Assignment.

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