Advanced Digital Communications (EQ2410)

Lecture 3, Period 2, 2016

Task 1 Gather in groups of 3-4 students, and discuss the running example for DFE.

Running example For the model (5.21), (5.22), (5.23) corresponding to our running example, we have

$$\mathbf{U}_f = \begin{pmatrix} 0 & 0 \\ 1 & 0 \\ \frac{1}{2} & 0 \\ -\frac{1}{2} & 1 \\ 0 & \frac{1}{2} \end{pmatrix}. \qquad (5.59)$$

Running example We compute the ZF-DFE, so as to avoid dependence on the noise variance. The feedforward filter is given by

$$\mathbf{c}_{\mathrm{FF}} = \mathbf{U}_f \left(\mathbf{U}_f^H \mathbf{U}_f\right)^{-1} \mathbf{e}.$$

Using (5.59), we obtain

$$\mathbf{c}_{\mathrm{FF}} = \frac{1}{13}(0, 10, 5, -1, 2)^T.$$

Since there is only one past ISI vector, we obtain a single feedback tap

$$\mathbf{c}_{\mathrm{FB}} = -\mathbf{c}_{\mathrm{FF}}^H \mathbf{U}_{\mathrm{p}} = \frac{5}{13},$$

since

$$\mathbf{U}_{\mathrm{p}} = (\frac{1}{2}, -\frac{1}{2}, 0, 0, 0)^T.$$

[Madhow, Fundamentals of Dig. Comm., 2008]

Task 2 Gather in groups of 3-4 students, and prove that $\mathrm{E}[T_c] = 1/P_{e,FF}$.

Task 3 Gather in groups of 3-4 students, and look at the error sequence trellis which is shown on the next page.

(a) Verify and explain to each other how the trellis is constructed.

(b) Verify that after an error has occurred it takes at least $L = 2$ correct decisions to come back to the all-zero path.

(c) At high SNR, the performance is limited by the error event $\boldsymbol{e}$ which minimizes $\|s(\boldsymbol{e})\|^2$, with (see Lecture 1, MLSE equalization)

$$\begin{aligned} \|s(\boldsymbol{e})\|^2 &= \sum_n \left(h[0]e^2[n] + 2e[n] \sum_{m=n-L}^{n-1} h[n-m]e[m] \right) \\ &= \sum_n e[n] \left(h[0]e[n] + 2 \sum_{m=n-L}^{n-1} h[n-m]e[m] \right). \end{aligned}$$

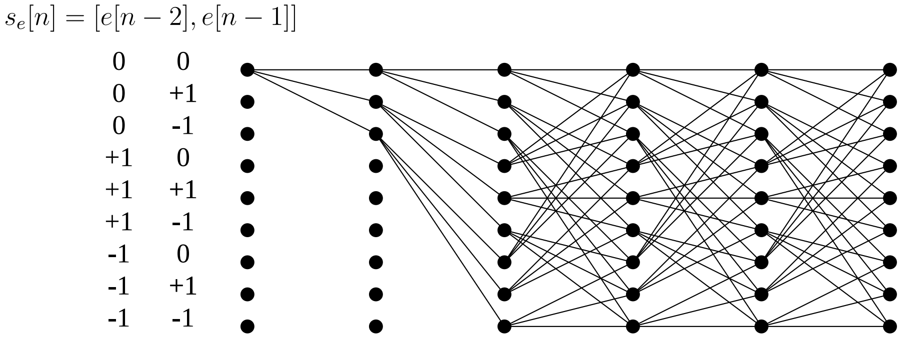
Calculate $\|s(\boldsymbol{e})\|^2$ for the simple error sequences

$$\begin{aligned} \boldsymbol{e}_1 &= [+1, 0, 0], \\ \boldsymbol{e}_2 &= [-1, 0, 0], \\ \boldsymbol{e}_3 &= [+1, +1, 0, 0] \end{aligned}$$

starting at time n and assuming that $s_e[n-1] = [0, 0]$.

(d) Which error sequence will dominate the performance at high SNR?

(a) Error Sequence Trellis



(b) Illustration of Simple Error Events