0.1 Static DFE Equalization (LTI Channel)

0.1.1 Static Channel Model

Let us consider the general case for transmitting a discrete-time binary signal, X, through an LTI channel (Fig. 2):

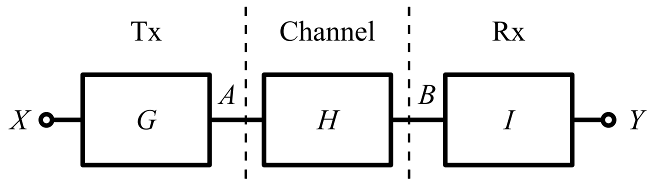

Figure 1: Channel equalization.

0.1.2 DFE Model

The goal of the Rx equalizer will be to re-construct a time-delayed version of X as the discrete-time binary signal, Y.

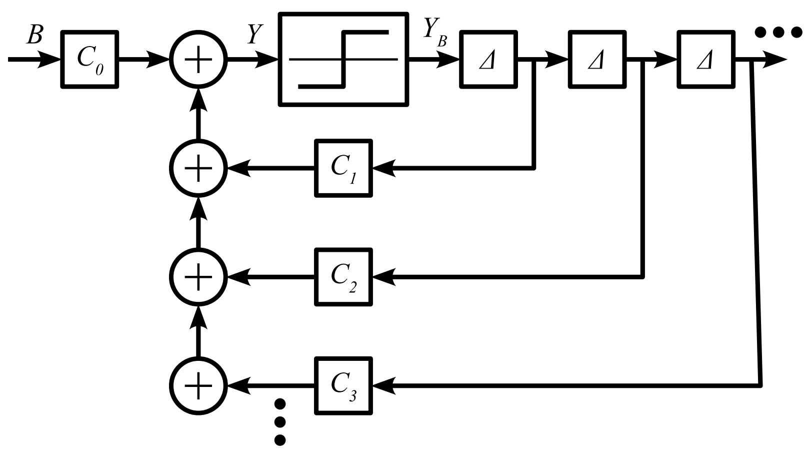

Figure 2: DFE Model.

To achieve this goal, the DFE from Fig. 2 will be used:

$$Y_S = C_0 B + \sum_{i=1}^{N} C_i Y_L e^{-j\omega(iT)}. \tag{1}$$

For the simple case where the transmit filter G is an ideal pulse generator, P:

$$B = XPH. \tag{2}$$

$$P = \begin{cases} 1, & 0 \le t \le T \\ 0, & \text{otherwise.} \end{cases} \tag{3}$$

Break the loop: In an ideal world, the DFE would reconstruct the original signal before sampling it:

$$Y_L = XPe^{-j\omega(D-T)}. \tag{4}$$

where D sets the sampling point right before the data is flopped.

Substituting (2), and (4) into (1), the DFE can therefore be expressed as:

$$Y_S = C_0 XPH + \sum_{i=1}^{N} C_i XP e^{-j\omega(iT+D-T)}. \tag{5}$$

$$\frac{Y_S}{X} = C_0 HP + P \sum_{i=1}^{N} C_i e^{-j\omega(iT+D-T)}. \tag{6}$$

0.1.3 Signal Sampling

$$\mathfrak{s}(t,D) \triangleq \sum_{-\infty}^{\infty} \delta\left(t-(nT+D)\right) \tag{7}$$

$$\mathfrak{s}(t,D) = \delta(t-D) * \sum_{-\infty}^{\infty} \delta\left(t-nT\right) \tag{8}$$

Thus,

$$\mathfrak{S}(D) \triangleq \mathfrak{F}\left\{\mathfrak{s}(t,D)\right\} \tag{9}$$

$$\mathfrak{S}(D) = \frac{2\pi e^{-j\omega D}}{T} \sum_{k=-\infty}^{\infty} \delta\left(\omega - \frac{2\pi k}{T}\right) \tag{10}$$

0.1.4 Amplitude Equalization

$$\frac{Y_S}{X} = e^{-j\omega D}, \qquad \forall t = iT + D \tag{11}$$

$$e^{-j\omega D} = C_0 HP + P \sum_{i=1}^{N} C_i e^{-j\omega(iT+D-T)}, \quad \forall t = iT + D \tag{12}$$

Part 1, $t = D$:

$$e^{-j\omega D} = C_0 HP, \qquad t = D \tag{13}$$

$$\delta(t-D) = C_0 h_P(t) \qquad t = D \tag{14}$$

$$C_0 = 1/h_P(D) \tag{15}$$

Part 2, $t = iT + D \quad i > 0$:

$$P \sum_{i=1}^{N} C_i e^{-j\omega(iT+D-T)} = e^{-j\omega D} - C_0 HP, \quad t = iT + D \quad i > 0 \tag{16}$$

$$P \sum_{i=1}^{N} C_i e^{-j\omega(iT+D-T)} = e^{-j\omega D} - C_0 HP, \quad t = iT + D \quad i > 0 \tag{17}$$

If we want to use arbitrary filter F with feedback coefficients:

$$C_i \Rightarrow FC_i, \quad i > 0. \tag{18}$$

Thus we get

$$P \sum_{i=1}^{N} C_i e^{-j\omega(iT+D-T)} = \frac{e^{-j\omega D} - C_0 HP}{F}, \quad t = iT + D \quad i > 0 \tag{19}$$

0.2 Matrix Test

$$\boldsymbol{V} = \boldsymbol{Z}\boldsymbol{I} \tag{20}$$

$$\begin{bmatrix} V_1 \\ V_2 \\ \vdots \\ V_N \end{bmatrix} = \begin{bmatrix} z_{11} & z_{12} & \cdots & z_{1n} \\ z_{21} & z_{22} & \cdots & z_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ z_{n1} & z_{n2} & \cdots & z_{nn} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ \vdots \\ I_N \end{bmatrix}. \tag{21}$$

Bibliography