① Equalization Filter

For a received signal P_n shown below

$P_n(0) = 1$, $P_n(1) = 0.3$; $P_n(-1) = -0.2$, $P_n(0) = 0.1$;

$P_n(-2) = 0.5$. Design 3 tap equalizer.

Solution

$$2N+1 = 3$$

$$\boxed{N=1}$$

$$P_o(k) = \sum_{n=-1}^{+1} C_n P_n(k-n) \quad (\text{2 Taps } n=-1, 0, 1)$$

For $k=0$

$$P_o(0) = \sum_{n=-1}^{+1} C_n P_n(-n)$$

$$P_o(0) = C_{-1} P_n(1) + C_0 P_n(0) + C_{+1} P_n(-1) \quad (n=-1, 0, 1)$$

For $k=-1$

$$P_o(-1) = C_{-1} P_n(0) + C_0 P_n(-1) + C_{+1} P_n(-2)$$

For $k=1$

$$P_o(+1) = C_{-1} P_n(2) + C_0 P_n(1) + C_{+1} P_n(0)$$

Write in matrix in decending order.

$$\begin{bmatrix} P_o(-1) \\ P_o(0) \\ P_o(+1) \end{bmatrix} = \begin{matrix} k \backslash n \\ -1 \\ 0 \\ 1 \end{matrix} \begin{matrix} -1 & 0 & 1 \end{matrix} \begin{bmatrix} P_n(0) & P_n(-1) & P_n(-2) \\ P_n(1) & P_n(0) & P_n(-1) \\ P_n(2) & P_n(1) & P_n(0) \end{bmatrix} \begin{bmatrix} C_{-1} \\ C_0 \\ C_{+1} \end{bmatrix}$$

$$P_0 = P_n C_n$$

$$C_n = P_n^{-1} P_0$$

$$\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 & -0.2 & 0.5 \\ -0.3 & 1 & -0.2 \\ 0.1 & -0.3 & 1 \end{bmatrix} \begin{bmatrix} C_{-1} \\ C_0 \\ C_{+1} \end{bmatrix}$$

$$P_n^{-1} = \begin{bmatrix} 1.06 & 0.05 & -0.52 \\ 0.31 & 1.08 & 0.05 \\ -0.01 & 0.31 & 1.06 \end{bmatrix}$$

$$\begin{bmatrix} C_{-1} \\ C_0 \\ C_{+1} \end{bmatrix} = \begin{bmatrix} 1.06 & 0.05 & -0.52 \\ 0.31 & 1.08 & 0.05 \\ -0.01 & 0.31 & 1.06 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} C_{-1} \\ C_0 \\ C_{+1} \end{bmatrix} = \begin{bmatrix} 0.05 \\ 1.08 \\ 0.31 \end{bmatrix}$$

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