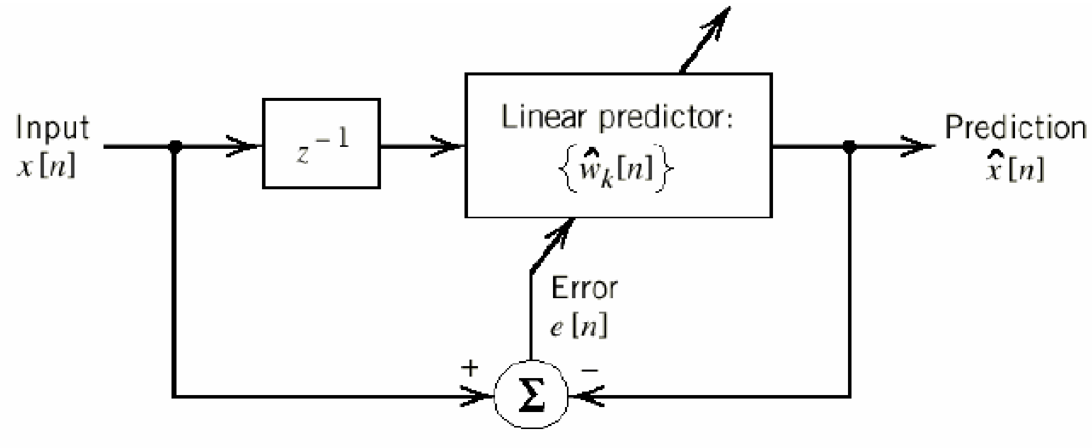
1. Please draw the block diagram of linear adaptive predictor. (hint: Chapter3-128)

Sol:



2.

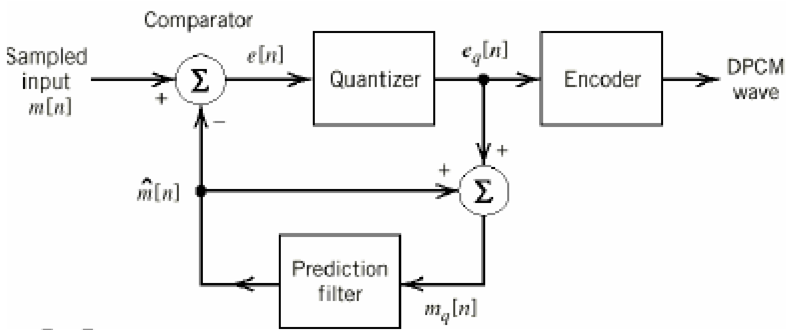
(a) Please draw the block diagram of DPCM system (both transmitter and receiver part), and briefly describe how does it work? (hint: Chapter 3-132)

(b) By (a), please derive SNR_O、SNR_Q and the Processing Gain G_P, and their relationship. (hint: Chapter 3-135)

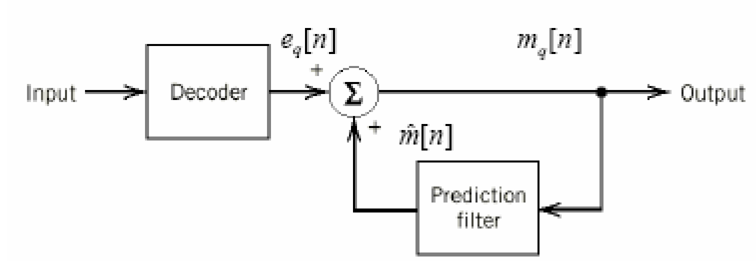
Sol:

(a)

(TX)



(RX)



$$e_q[n] = e[n] + q[n]$$

$$\Rightarrow \quad m_q[n] = \hat{m}[n] + e_q[n]$$

$$= \hat{m}[n] + e[n] + q[n]$$

$$= m[n] + q[n]$$

(b)

- The DPCM system can be described by:

$$m_q[n] = m[n] + q[n]$$

- So the output signal-to-noise ratio is:

$$SNR_O = \frac{E[m^2[n]]}{E[q^2[n]]}$$

- We can re-write SNR_O as:

$$SNR_O = \frac{E[m^2[n]]}{E[e^2[n]]} \frac{E[e^2[n]]}{E[q^2[n]]} = G_p \cdot SNR_Q$$

where $e[n] = m[n] - \hat{m}[n]$ is the prediction error.

3. A DPCM system uses a linear predictor with a single tap. The normalized autocorrelation function of the input signal for a lag of one sampling interval is 0.75. The predictor is designed to minimize the prediction error variance. Determine the processing gain attained by the use of this predictor. (hint: Problem 3.34)

   Sol:

Input signal variance = $R_x(0)$

The normalized autocorrelation of the input signal for a lag of one sample interval is

$$\rho_x(1) = \frac{R_x(1)}{R_x(0)} = 0.75$$

$$\text{Error variance} = R_x(0) - R_x(1)R_x^{-1}(0)R_x(1)$$

$$= R_x(0)(1 - \rho_x^2(1))$$

$$\text{Processing gain} = \frac{R_x(0)}{R_x(0)(1-\rho_x^2(1))}$$

$$= \frac{1}{1-\rho_x^2(1)}$$

$$= \frac{1}{1-(0.75)^2}$$

$$= 2.2857$$

Expressing the processing gain in dB, we have

$$10\log_{10}(2.2857) = 3.59 \text{ dB}$$