

DPCM CODING

$e_p(n) = \text{prediction error} = x(n) - x_p(n)$

P = Predictor
Q = Quantizer

$Q(n) = \text{Quantization error} = e_p(n) - e_{pq}(n)$

Feedback prediction
ADAPTIVE QUANTIZER

$\hat{x}(n) = \text{Reconstructed signal} = e_{pq}(n) + x_p(n)$

$x(n) = \text{Input signal}$

$x_p(n) = \text{Predicted value of } x(n)$

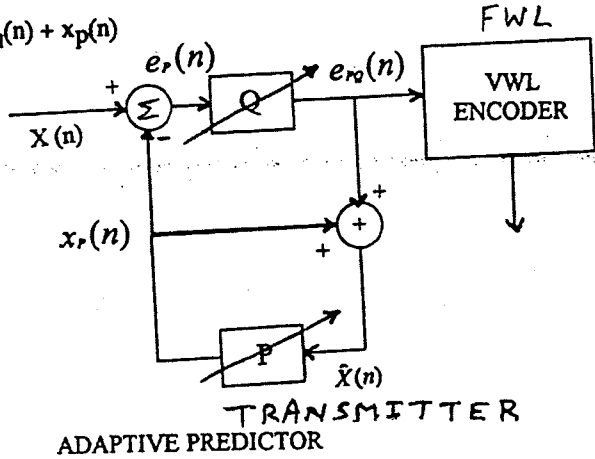
Reconstruction error

$= x(n) - \hat{x}(n)$

$= e_p(n) - e_{pq}(n) = q(n)$

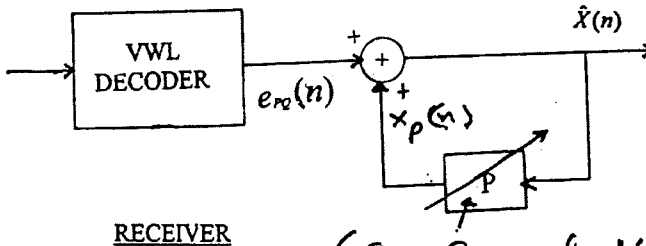
$= x_p(n) + e_p(n) - [e_{pq}(n) + x_p(n)]$

$= \text{quantization error}$



TRANSMITTER
ADAPTIVE PREDICTOR
TRANSMITTER

Adaptive DPCM involves adaptive predictor and/or adaptive quantizer.



RECEIVER

(Same as at the transmitter)

2. A sample image is shown in Table 13.8. Both LPF and HPF are given, decompose the sample image into 2D four equal subbands. Identify the LL, LH, HL & HH subbands. Assume reflection of pixel intensities at the borders.

Averaging | HPF Differencing

LPF $y_n = \frac{x_n + x_{n-1}}{2}$ | $z_n = \frac{x_n - x_{n-1}}{2}$

TABLE 13.8 A sample "image."

10	14	10	12	14	8	14	12
10	12	8	12	10	6	10	12
12	10	8	6	8	10	12	14
8	6	4	6	4	6	8	10
14	12	10	8	6	4	6	8
12	8	12	10	6	6	6	6
12	10	6	6	6	6	6	6
6	6	6	6	6	6	6	6

3.

a) Design the codebook using LBG algorithm. Set the threshold $\epsilon = 0.001$.

Codebook design starting with an uniform quantizer

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$K = 2,$ (Vector dimension) $M = 4,$ (Codebook size) $n = \#$ of vectors in the training sequence, $n = 12,$

$x_1 = (-.37, .99)$ $x_7 = (-.6, .18)$

$x_2 = (.64, -.12)$ $x_8 = (.14, 1.76)$

$x_3 = (-.83, .61)$ $x_9 = (.71, -.35)$

$x_4 = (-.71, -1.22)$ $x_{10} = (.3, +.8)$

$x_5 = (-.29, -.95)$ $x_{11} = (.3, 1.07)$

$x_6 = (1.1, .52)$ $x_{12} = (-.38, -.33)$

LBG ALGORITHM

b) Describe in detail splitting algorithm for designing codebook. How is this useful for BSVQ? What is the empty cell problem? How can this be corrected?

4. If $h_1(n) = h_1(N-1-n)$, $0 \leq n \leq \frac{N}{2}-1$, represents a LPF (Symmetric), then its

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QMF corresponds to $h_2(n) = (-1)^n h_1(n)$.

- a) How are the frequency spectra of $H_1(z)$ and $H_2(z)$ related. Sketch them.
- b) Why are they called QMF pair?

5.

a) Show in a block diagram format (using LPF, HPF and decimators) how you can obtain the subband decomposition shown below.

b) Repeat a) to obtain the original (512 x 512) image, ie, Subband synthesis (using also interpolators).

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