Quantization

% lecture-4

- transformation of signal $x[n]$ into one of a set of prescribed values.
- it is a process of transforming the sample amplitude $x(nT_s)$ of a message signal $x(t)$ at time $t = nT_s$ into discrete amplitude $x\prime(nT_s)$ taken from a finite set of possible amplitude.
- the process is memory less.
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$$m(t) \to max(m(t) = m_{max} min(m(t) = m_{min}$$

Non uniform

$$\Delta = \frac{m_{max} - m_{min}}{L}$$

$L = 2^n$

Uniform

Quantization

$$L = 2^n$$

Quantization Noise

$$\frac{S}{N_q} = \frac{12P_s}{(\frac{m_{max}-m_{min}}{L})^2}$$

- Case 1: m(t) is a sinusoid

  m_max = m_min = A_m

  $P_s = \frac{A_m^2}{2}$

$$\frac{S}{N_q} = \frac{12A_m^2}{2} \times \frac{2^{2n}}{A_m - (-A_m)^2} = \frac{3}{2}2^{2n}$$

$$(\frac{S}{N_q})_{dB} = 10\log_{10}\frac{3}{2}2^{2n} = 6.02n + 1.8dB$$

- Case 2: m(t) is uniform RV with zero mean

$$m_{max} = -m_{min} = A_m$$

$$P_s = \frac{(A_m - (-A_m))^2}{12} = \frac{A_m^2}{3}$$

Encoder:

Gives codewords to each quantization level

- -8 0 000
- -6 1 001
- -4 2 010
- -2 3 011
- 0 4 100
- 2 5 101
- 4 6 110
- 6 7 111

Sampling Rate

Sampling frequency = f_s

Encoder Bits = n

Bit rate of transmission R_b= $n \times f_s bits/s$

1 Baud = k bits combined to make a symbol

Baud Rate = bit rate/ k = Symbol rate or signalling rate

If not mentioned then k = n

Baud rate = sampling rate

Minimum theoretical bandwithd required for transimmision = $\frac{R_b}{2}$Hz

$$X(m,n) = \begin{Bmatrix} x(n), & \text{for } 0 \leq n \leq 1 \\ x(n-1), & \text{for } 0 \leq n \leq 1 \\ x(n-1), & \text{for } 0 \leq n \leq 1 \end{Bmatrix} = xy$$