CT303 Digital Communication Autumn, 2018

Lab. 5 Quantization and binary PCM

1. Consider a signal x(t)=2π(3000)t. Sample this signal at 24000 samples/sec and generate x[n]. Consider one cycle of x[n], obtain uniformly quantized samples. Take number of Quantization Levels as 8. Plot x[n] and x_q[n] sequences. Now compute signal power to quantization error power ratio in dB (SNR_{dB}) by computing the two powers. Also encode the quantized signal x[n] using the Pulse Code Modulation.
   Repeat the same for quantization levels as 16.

2. For the same signal as in Q1, plot the error vs number of bits/sample by considering various quantization levels.

3. Illustration of Uniform and Non-Uniform Quantization on Speech Signal:
   Take an audio file sampled at 16,000 samples/sec. Perform uniform quantization with number of quantization levels as 32. Compute the SNR. Now perform the same experiment for non-uniform quantization.Listen to (a) The Original Speech (b) Uniformly Quantized Speech (c) Non-uniform Quantized Speech. What conclusions can you infer?
   Use μ-law companding with μ=255 for non-uniform quantization.

   μ-law encoding:

$$y = F(x) = sgn(x)\frac{log_e[1 + \mu(|x| / x_{max})]}{log_e(1 + \mu)}$$

   Where,

$$sgn\ x = \begin{cases} +1 & \text{for } x \geq 0 \\ -1 & \text{for } x < 0 \end{cases}$$

   And take $x_{max} = max\ (abs(x))$

   μ-law expansion:

$$x = F^{-1}(y) = \frac{sgn(y)}{\mu}\ ((1 + \mu)^{|y|} - 1)$$