HACETTEPE UNIVERSITY
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
ELE 409: DIGITAL SIGNAL PROCESSING LABORATORY

# EXPERIMENT 3 - QUANTIZATION

## I. PURPOSE

The main purpose of this experiment is to study the quantization of discrete-time signals. Two basic quantizer types are compared with each other. Signal level mismatch & effect of increasing the number of bits of quantizer is investigated. Example for adaptive quantization approach is presented for speech signal.

- Learn how to use the following built-in functions and the reason why do we use:
  *audioread, max, min, mean, var, sign, ceil, floor, round, histogram, histcounts.*
- Frequency range should be $[-\frac{f_s}{2}, \frac{f_s}{2}]$ in your frequency domain figures.

## II. PRELIMINARY WORK

1. Generate a discrete-time sinusoidal signal $\mathbf{x}$[n] with the SinSamples() function implemented in preliminary work of experiment 1, with the parameters: $A = 3, w = 2\pi,\ w_s = 2\pi 50,\ \theta = 0,\ d = 2sec.$

   (a) Implement 3-bit midrise type quantizer. Make the reconstruction levels be spaced so as to span the entire amplitude range of the signal. You may use the maximum amplitude of the signal in designing reconstruction levels. Plot original signal, quantized version, and quantization error. Calculate output signal to noise ratio (SNR) in dB (all signal to noise ratios must be calculated in dB).

   (b) Implement 3-bit midtread type quantizer (This time quantizer will be asymmetric). Plot original signal, quantized version, and error. Calculate output SNR.

2. In order to see the effect of signal level mismatch in your designed midrise type quantizer, obtain the signals $\mathbf{x_1}[n] = 0.5\mathbf{x}[n]$ and $\mathbf{x_2}[n] = 2\mathbf{x}[n]$, but do not modify the quantizer. Calculate output SNRs, and comment on the results.

3. Load the file *sound3.wav*. Encode the data using 3-bit uniform midrise type quantizer (again, space reconstruction levels so as to span the entire amplitude range of the signal). Listen the original and encoded versions. Calculate the output SNR, and plot the error signal.

4. Do the procedure in question 3 with a 4-bit uniform midrise type quantizer. Comment on results by comparing with question 3.

5. Better approach in speech quantization, is segmentation. Partition the utterance, into segments of 100 samples. Now, quantize these segments individually as in question 1a (place reconstruction levels in each segment considering the maximum amplitude range in corresponding segment). Listen the original and encoded versions. Calculate the output SNR and plot the error. Comment on the results by comparing with question 3.