

## MATLAB Exercise – Quantizer Characteristics

**Program Directory:** speech\_coding/quantizer\_characteristic

**Program Name:** quantizer\_characteristic\_GUI25.m

**GUI data file:** Quantizer\_Characteristic.mat

**Callbacks file:** Callbacks\_quantizer\_characteristic\_GUI25.m

**TADSP:** Sections 11.4.1-11.4.2, pp. 680-696, Problems 11.25, 11.27

This MATLAB exercise illustrates the processes involved in quantizing speech waveform samples using both a uniform and a logarithmic (mu-law) quantizer.

### Quantizer Characteristics – Theory of Operation

The exercise divides the speech level interval between  $-1$  and  $+1$  into  $2^B$  uniform intervals (for a uniform quantizer) and into  $2^B$  pseudo-logarithmically spaced intervals (for a mu-law quantizer). The exact locations of each quantization interval depends on whether the quantization uses mid-riser or mid-tread intervals, and it also depends on whether the quantization uses rounding and saturating intervals, or truncating and saturating intervals.

### Quantizer Characteristics – GUI Design

The GUI for this exercise consists of two panels, 2 graphics panels, 1 title box and 6 buttons. The functionality of the two panels is:

1. one panel for the graphics display,
2. one panel for parameters related to the speech coding and quantization parameters, and for running the program.

The set of two graphics panels is used to display the following:

1. the quantization characteristics of either a uniform or a mu-law compression quantizer with a mid-tread quantization characteristic,
2. the quantization characteristics of either a uniform or a mu-law compression quantizer with a mid-riser quantization characteristic.

The title box displays the information about the selected file along with the set of signal quantization parameters. The functionality of the 6 buttons is:

1. an editable button that specifies the value of  $\mu$ ; (the default is  $\mu=40$ ),
2. an editable button that specifies the number of bits,  $n_{bitsu}$ , for a uniform quantizer; (the default is  $n_{bitsu}=4$ ),
3. an editable button that specifies the number of bits,  $n_{bit\mu}$ , for a mu-law quantizer; (the default is  $n_{bit\mu}=4$ ),
4. a pushbutton to run the code and display the quantizer characteristics for a uniform quantizer with the selected quantization parameters,
5. a pushbutton to run the code and display the quantizer characteristics for a mu-law quantizer with the selected quantization parameters,
6. a pushbutton to close the GUI.

## Quantizer Characteristics – Scripted Run

A scripted run of the program 'quantizer\_characteristics\_GUI25.m' is as follows:

1. run the program 'quantizer\_characteristic\_GUI25.m' from the directory:

'matlab\_gui\speech\_coding\quantizer\_characteristics',

2. using the editable buttons, set the initial values for the signal processing parameters as  $\mu=40$ ,  $nbitsu=4$ , and  $nbitsmu=4$ ,
3. hit the 'Run Uniform Quantization' button to compute and display the characteristics of a uniform quantizer (mid-tread in the upper graphics panel and mid-riser in the lower graphics panel) with  $nbitsu$  used to determine the quantized value,
4. hit the 'Run mu-law Quantization' button to compute and display the characteristics of a mu-law quantizer (mid-tread in the upper graphics panel and mid-riser in the lower graphics panel) with  $nbitsmu$  used to determine the quantized value,
5. experiment with different choices of speech file, and with different values for  $\mu$ ,  $nbitsu$ , and  $nbitsmu$ ,
6. hit the 'Close GUI' button to terminate the run.

Two examples of the graphical output obtained from this exercise are shown in Figures 1- 2. The plots in Figure 1 show the quantization characteristics of a uniform quantization of the interval from  $-1$  to  $+1$  using  $nbitsu$  bits, for both a mid-tread (upper graphics panel) and a mid-riser (lower graphics panel) uniform quantizer.

The graphics panels in Figure 2 show the mu-law quantizer characteristics for mu-law quantization, using  $nbitsmu$  bits, for both a mid-tread (upper graphics panel), and a mid-riser (lower graphics panel) quantizer characteristic following mu-law encoding.

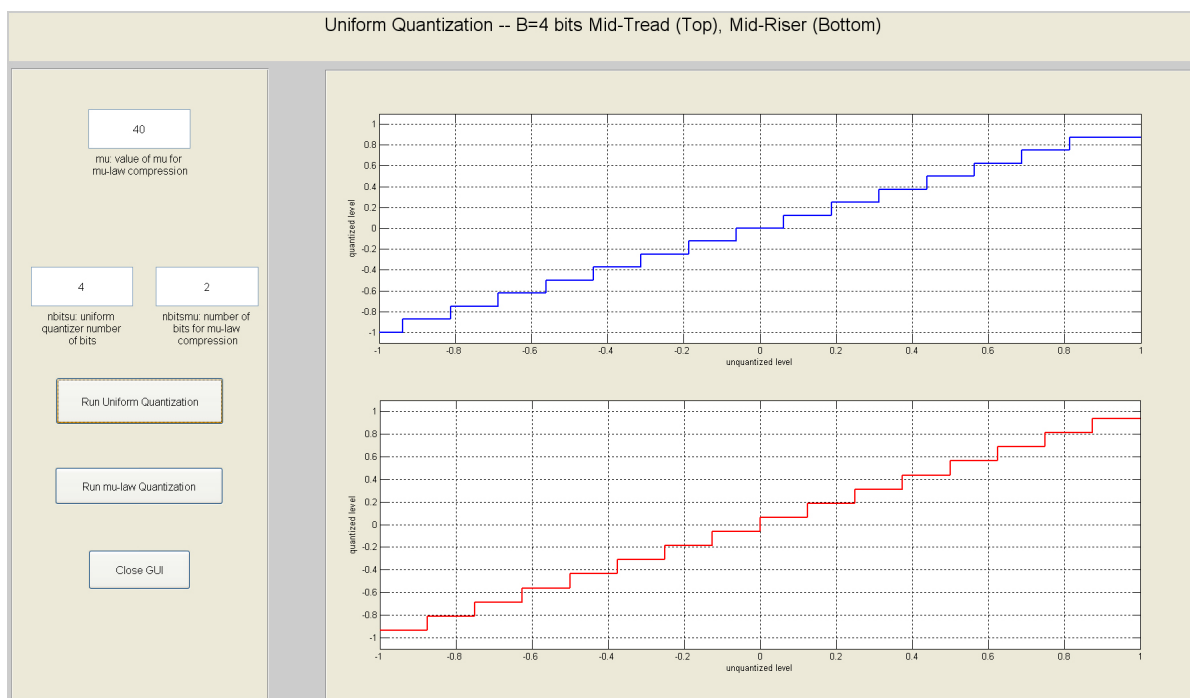


Figure 1: Graphical output showing quantizer characteristics of either a uniform quantizer. The upper graphics panel shows the quantization characteristics for a mid-tread uniform quantizer with  $\text{nbitsu}=4$ ; the lower graphics panel shows the quantization characteristics for a mid-riser uniform quantizer with  $\text{nbitsu}=4$ .

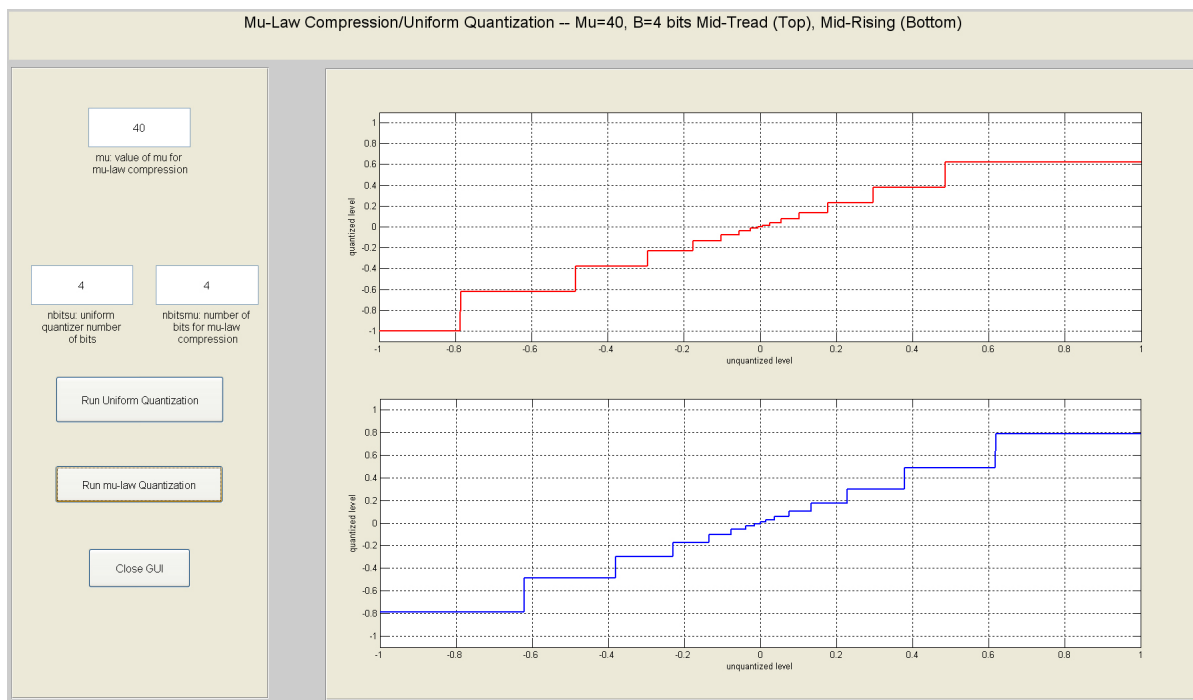


Figure 2: Graphical output showing quantizer characteristics of either a mu-law quantizer with a value of  $\mu=40$ . The upper graphics panel shows the quantization characteristics for a mid-tread, mu-law quantizer with  $\text{nbitsmu}=4$  and  $\mu=40$ , and the lower graphics panels shows the quantization characteristics for a mid-riser, mu-law quantizer with  $\text{nbitsmu}=4$  and  $\mu=40$ .