The submission includes the script, **main.m**, and two function files for mid-tread quantization: **quantizeAudio.m** and **quantizaMidTread.m**, three function files for nonlinear quantization: **Alaw.m**, **mulaw.m,** and **nonLinearQuantAudio.m**. The **main.m** file is used to plot the examples using generated sine wave and **piano.wav** provided in the folder.

I. Uniform Quantization

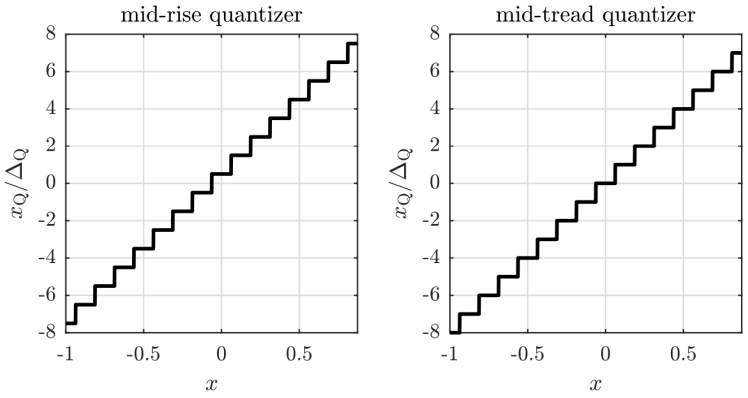

Fig 1: Mid-tread Quantizer

According to the lecture, we can write the mid-tread quantizer as the equation below:

$$\frac{x_Q}{\Delta_Q} = \lfloor \frac{x}{\Delta} + \frac{1}{2} \rfloor$$

The basic idea is to rescale the original audio input signal by range, then quantize each point with the clipping. Finally, rescale the quantized points back to the original range. We can find the clipping on the plot by setting the **max_value** and **min_value** in the **quantizeMidTread.m** file.

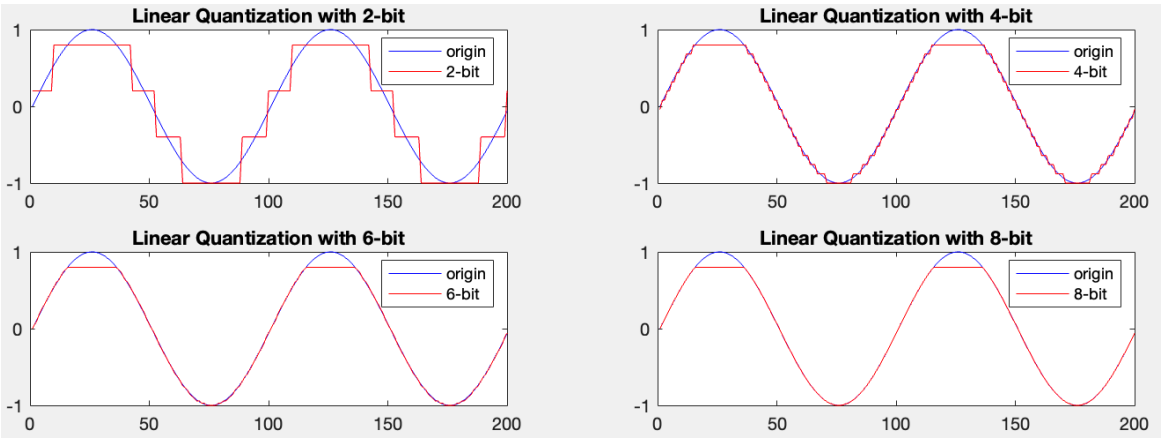

Fig 2: Sine wave quantization with different word lengths (clipping)

Fig 2 shows the quantization of generated sine wave. It includes four subplots which were quantized with different word lengths respectively. Fig 3 shows the quantization of

the first 200 points of the example audio. We can find the 8-bit quantization is very close to the original signal. Fig 4 and Fig 5 show the non-clipping case.

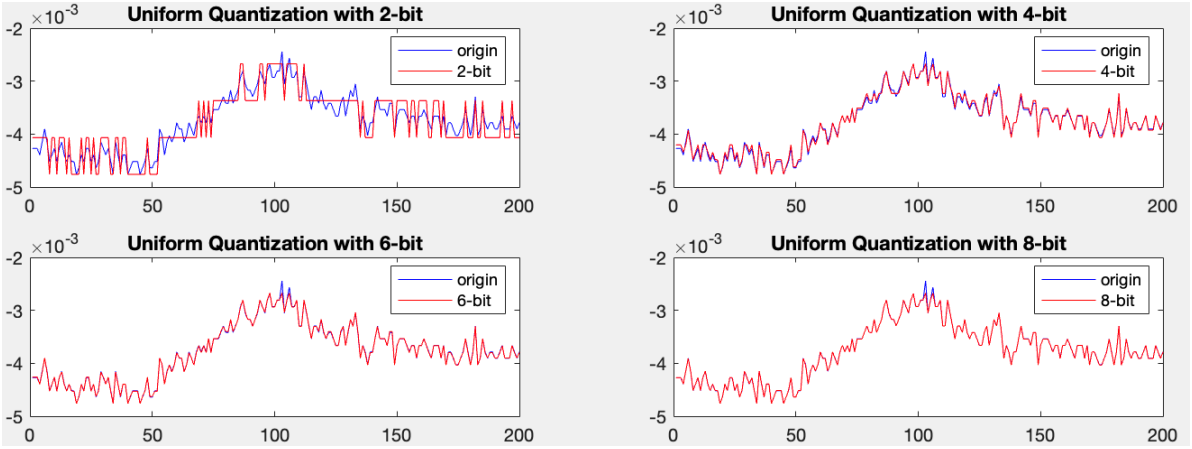

Fig 3: Example signal quantization with different word lengths (clipping)

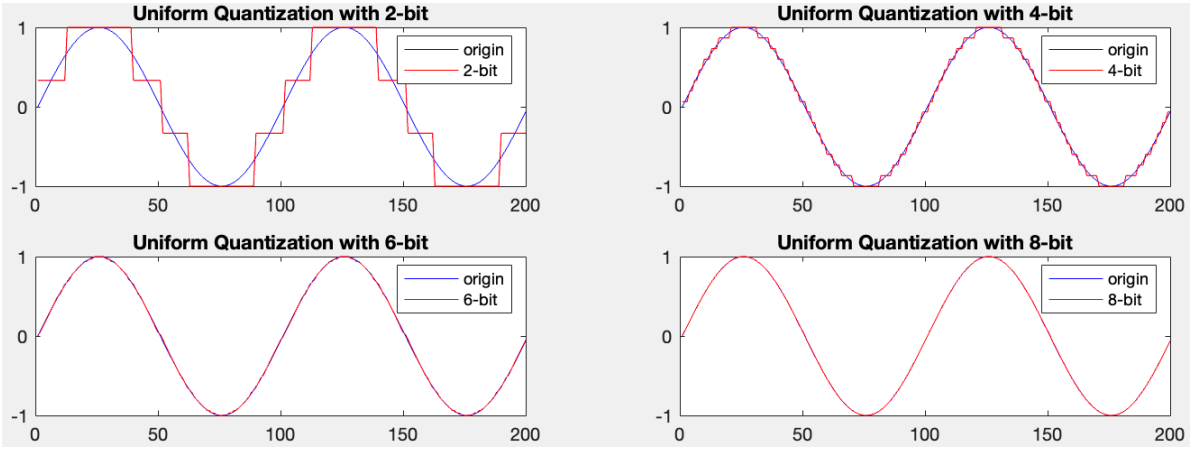

Fig 4: Sine wave quantization with different word lengths (without clipping)

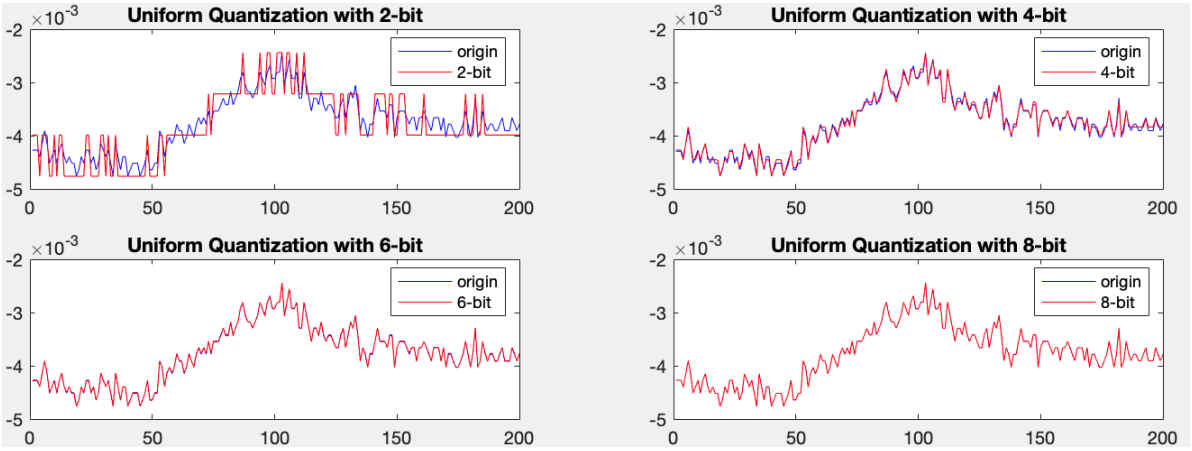

Fig 5: Example signal quantization with different word lengths (without clipping)

II. Nonuniform Quantization

1. A-law

The equations for A-law are shown as follows:

$$F(x) = sign(x)\begin{cases} \frac{A|x|}{1+log(A)} & , |x| \le \frac{1}{A} \\ \frac{1+log(A|x|)}{1+log(A)} & , \frac{1}{A} \le |x| \le 1 \end{cases}$$

$$F^{-1}(y) = sign(y)\begin{cases} \frac{|y|(1+log(A|)}{A} & , |y| \le \frac{1}{1+log(A)} \\ \frac{exp(|y|(1+log(A))-1)}{A} & , \frac{1}{1+log(A)} \le |y| \le 1 \end{cases}$$

With $A = 87.7$.

Fig 6 and Fig 7 show the implementation of A-law quantization.

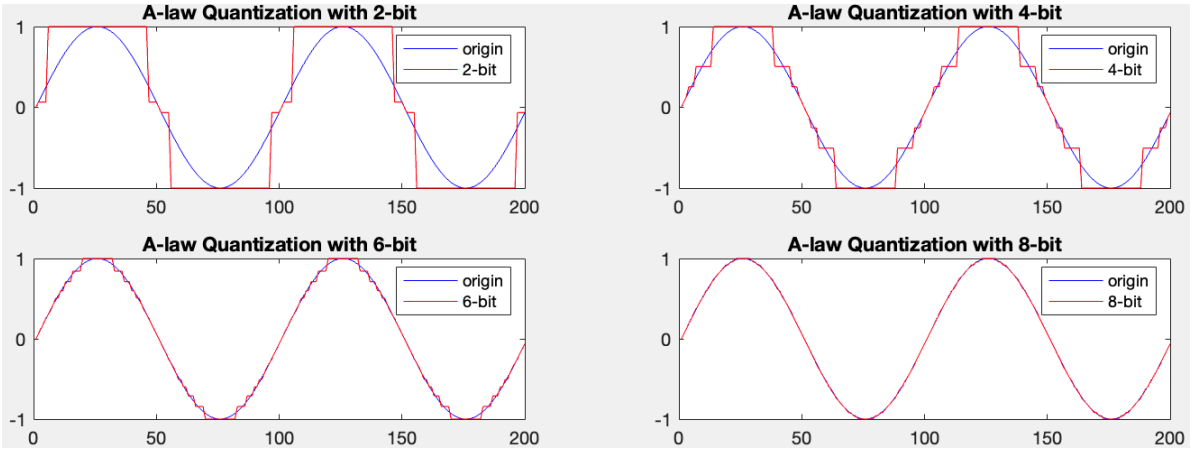

Fig 6: A-law quantization of generated sine wave

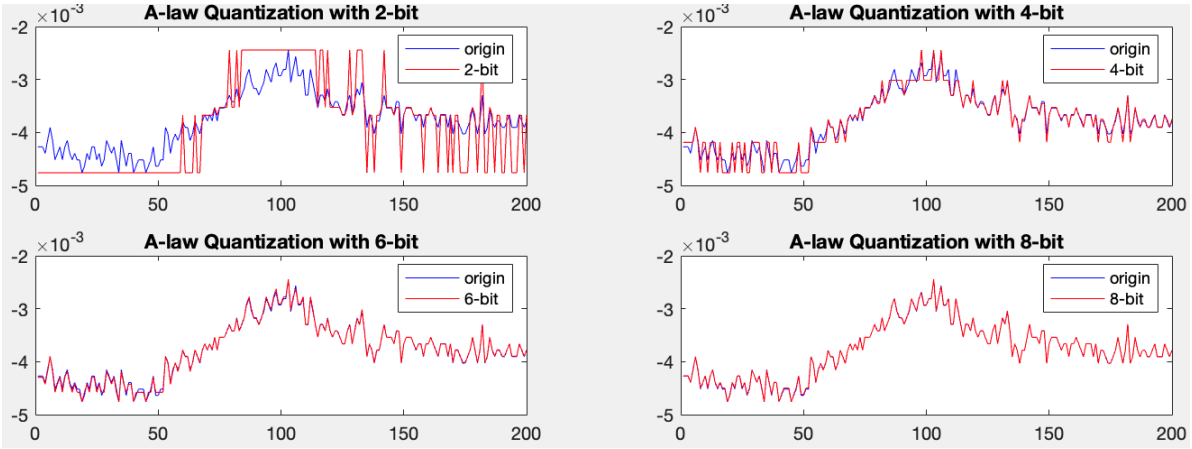

Fig 7: A-law quantization of the example audio signal

2. mu-law

The equations for mu-law are shown as follows:

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

With $\mu = 255$.
Fig 8 and Fig 9 show the implementation of mu-law quantization.

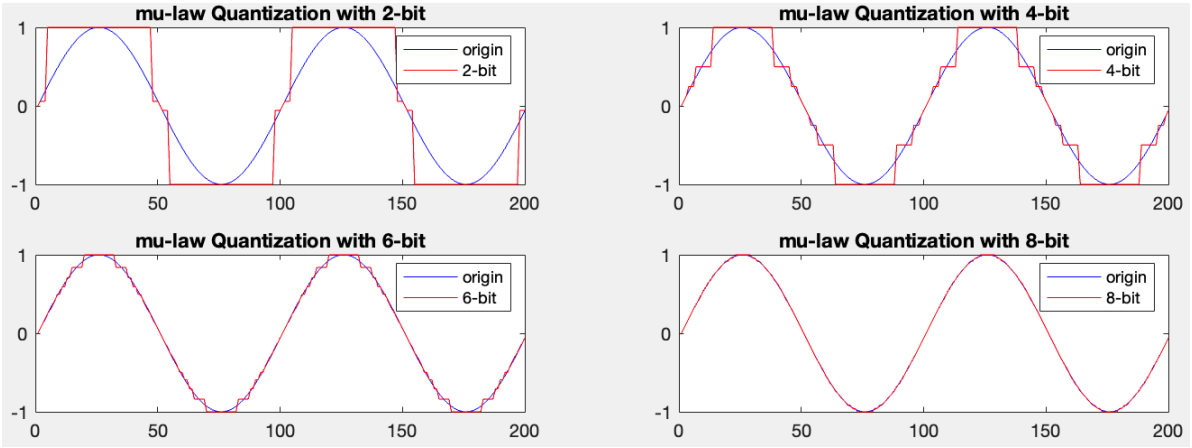

Fig 8: mu-law quantization of generated sine wave

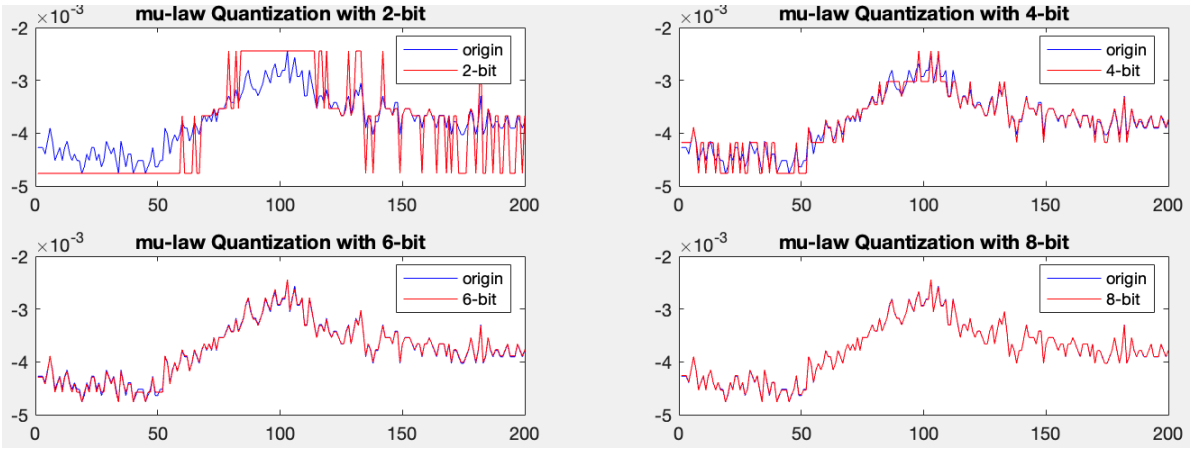

Fig 9: mu-law quantization of the example audio signal