EQ2320 - Speech Signal Processing

Requirement Analyse and System Design

Final Report

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I Introduction

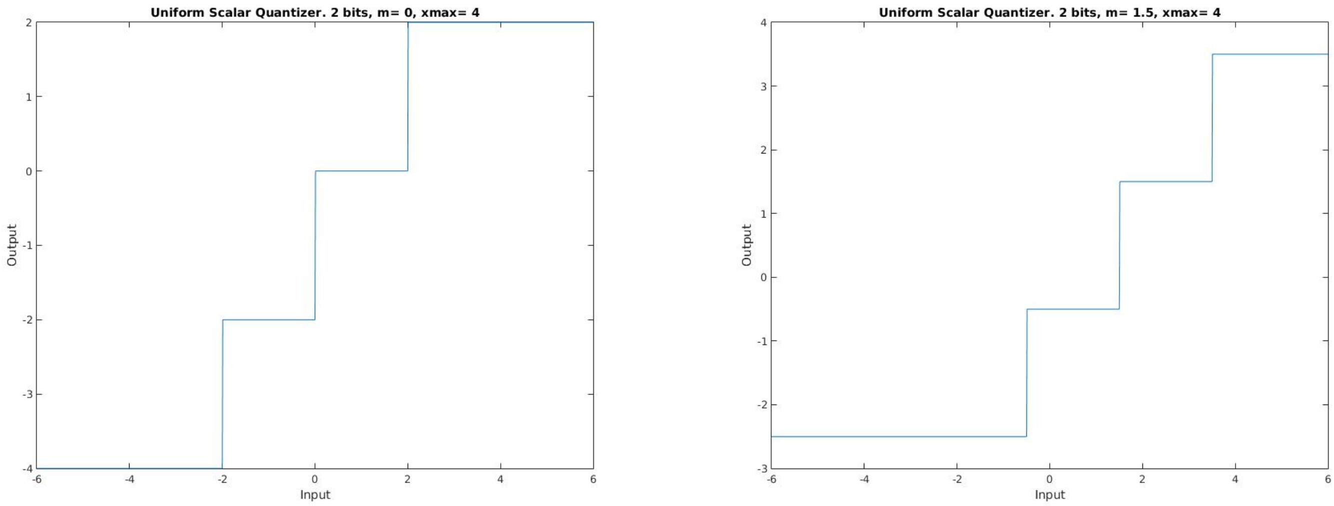
II Uniform Scalar Quantizer

In this part we implement the most basic quantizer. The USQ is entirely defined with three parameters :

— n_{bits}, the number of bits used to code one sample. $2^{n_{bits}}$ is the number of output value ;
— m, the mean of the output values ;
— xmax the maximum of the output values ;

In this part we tried m=0 and m=1.5. The result that we got plotting the input sigal versus the input signal is presented on figure 1.

To compare the two settings, we need to plot the distorsion-rate curve and compare the performance. This is presented on figure 2.



(a) m = 0

(b) m = 1.5

FIGURE 1 – Input vs Output

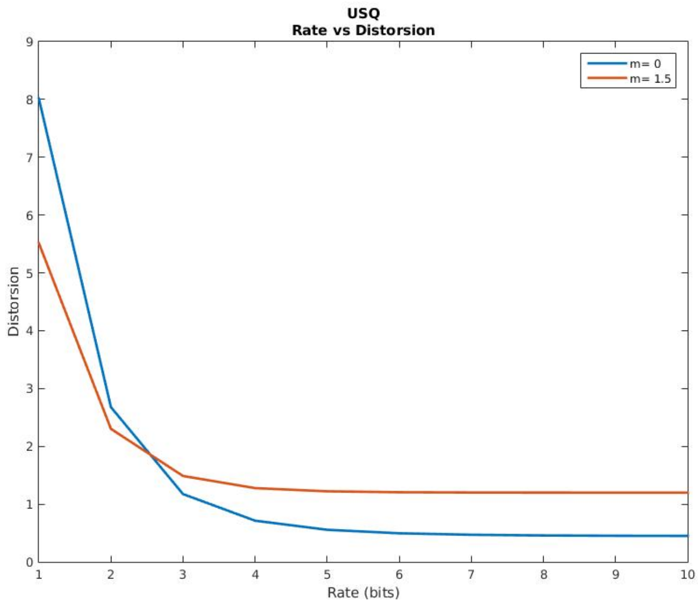


FIGURE 2 – Rate-Distorsion curve for two values of m.

III Parametric coding of speech

IV Speech Waveform Quantization

IV.1 Evaluation of the optimal k

In this part we design a Uniform Scalar Quantizer (USQ) that is adapted to the speech signal. For that we define

$$xmax = k\sigma_x$$

where σ_x^2 is the variance of the speech signal. This kis to be calculate for everybit rate we choose. The value of k for a bitrate R = 3 is 2.57. The figure 4 shows a plot of SNR = f(k). The SNR has been evaluate with the following formula

$$SNR = \frac{\sigma_x^2}{\frac{1}{N}\sum_{n=1}^{N}(x_n - q_R(x_n))^2}$$

where N is the size of the input speech signal, x_n is the input speech signal, $q_R(x_n)$ is the input signal quantized with a bitrate R. Here R=3.

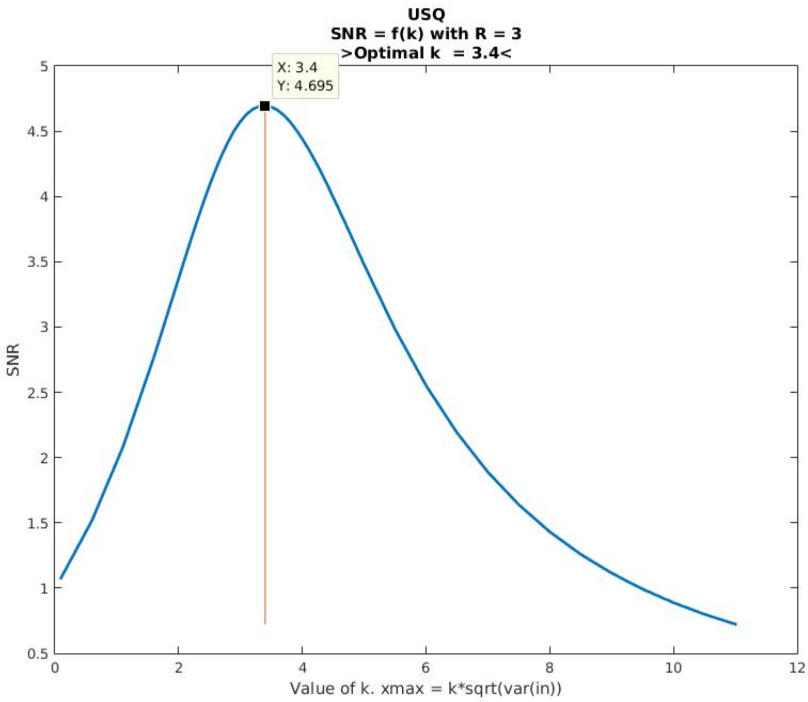


FIGURE 3 – SNR = f(k) for a bitrate R = 3

IV.2 Rate - SNR curve

The curve ploted on figure **??**, represents the rate versus the SNR_{dB}. The SNR_{dB} has beenevaluated with the following formula :

$$SNR_{dB} = 10log_{10}\frac{\sigma_x^2}{\frac{1}{N}\sum_{n=1}^{N}(x_n - q_R(x_n))^2}$$

where N is the size of the input speech signal, x_n is the input speech signal, $q_R(x_n)$ is the input signal quantized with a bitrate R.

IV.3 Quality of the quantized signal

A bit rate of 8 bits provides a good quality for the quantized signal.

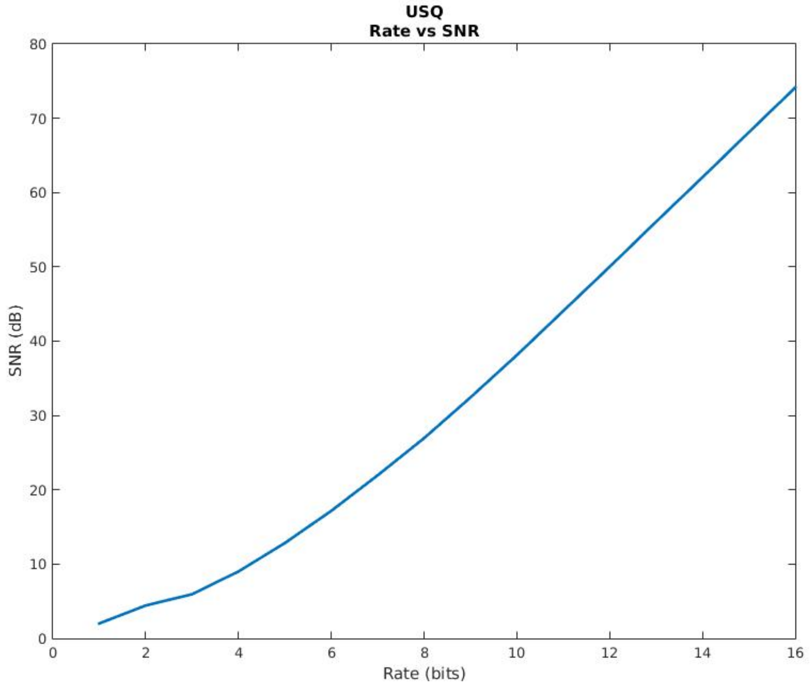


FIGURE 4 – Rate versus SNR curve, for rate = {1,2,...,16}

IV.4 Error signal

For a bit rate of 1 bit, the error signal contains of the information. It is easier to unserstand the message by listening to the error signal than listening to the quantized signal. The error signal is then highly correlated with the input signal. That compromises one of the fundamental assumptions when we want to remove an additive noise on a signal. On the otherhand when the rate is high, say 11 bits, the error signal sounds like a white noise and is consequently totally decorrelated with the input signal.

IV.5 OPTIONAL :

With a midtreat quantizer, the message is more understandable a low bitrate and at high bitrate there are no differences. The figure 5 shows the selected levels for a 2 bits midtreat quantizer.

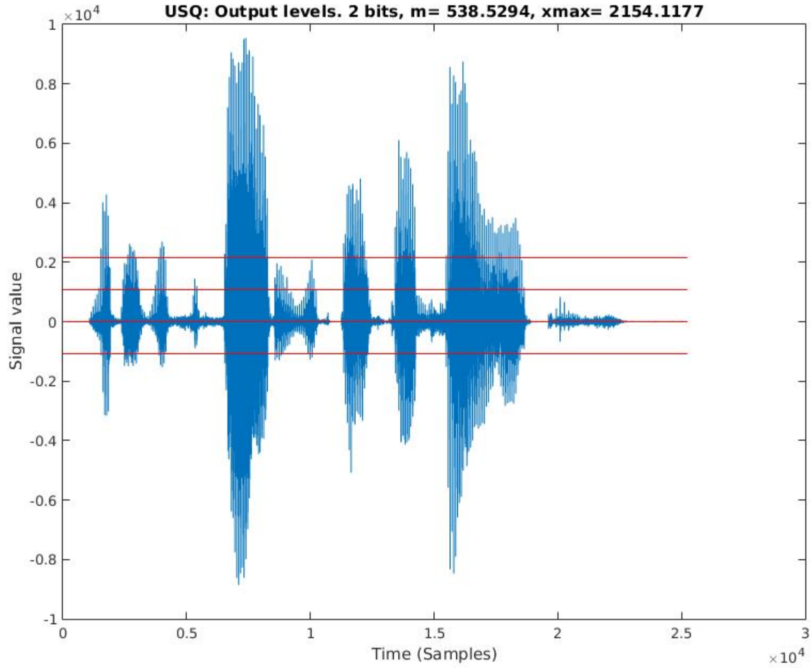


FIGURE 5 – Midtreat quantizer for R = 2

V Adaptive Open-Loop DPCM

In this section we have to implement an a Differential Pulse Code Modulator. The functional scheme is presented on figure 6.

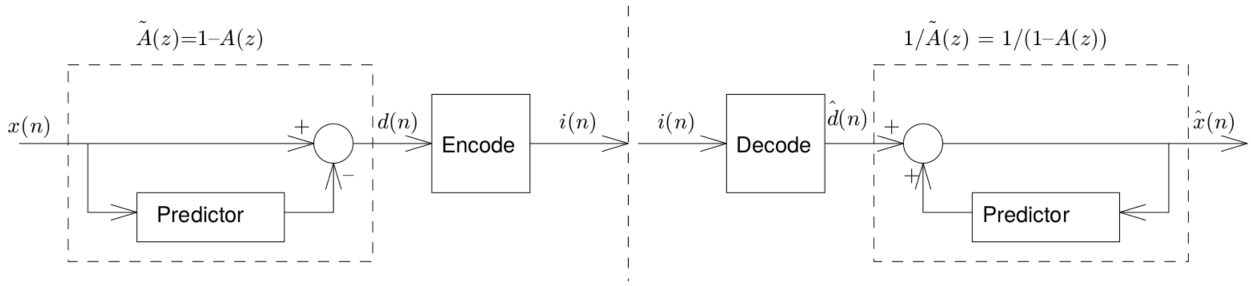


FIGURE 6 – Functional scheme of a DPMC

The idea here is to perform a linear prediction on an input signal, and to transmit the error signal with the prediction coefficient. It is not efficient to transmit a quantized input because the frames are strongly correlated between each other, as we can see on figure 7.

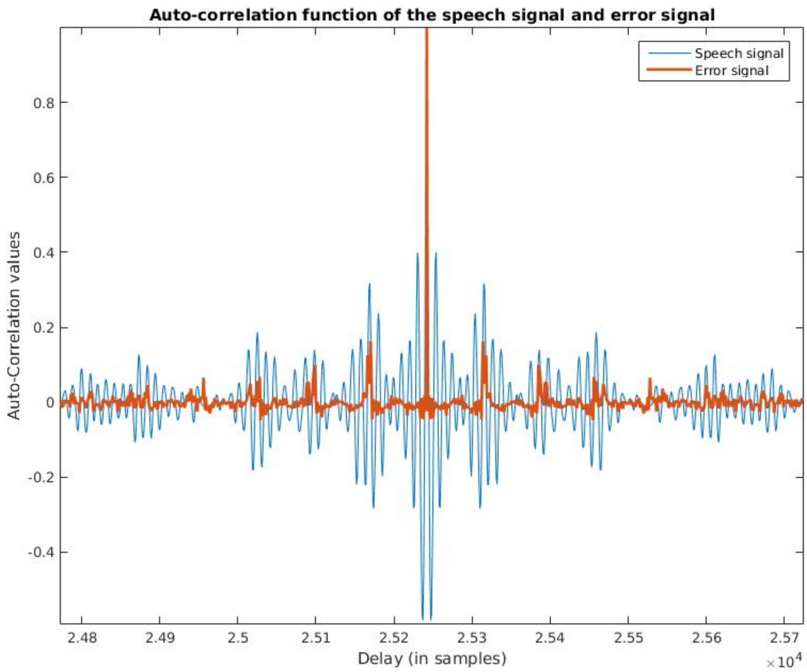


FIGURE 7 – Correlation function of the input speech signal.