ECE 438 Lab, division 1
Lab 08 (week 12): Number Representation and Waveform Quantization

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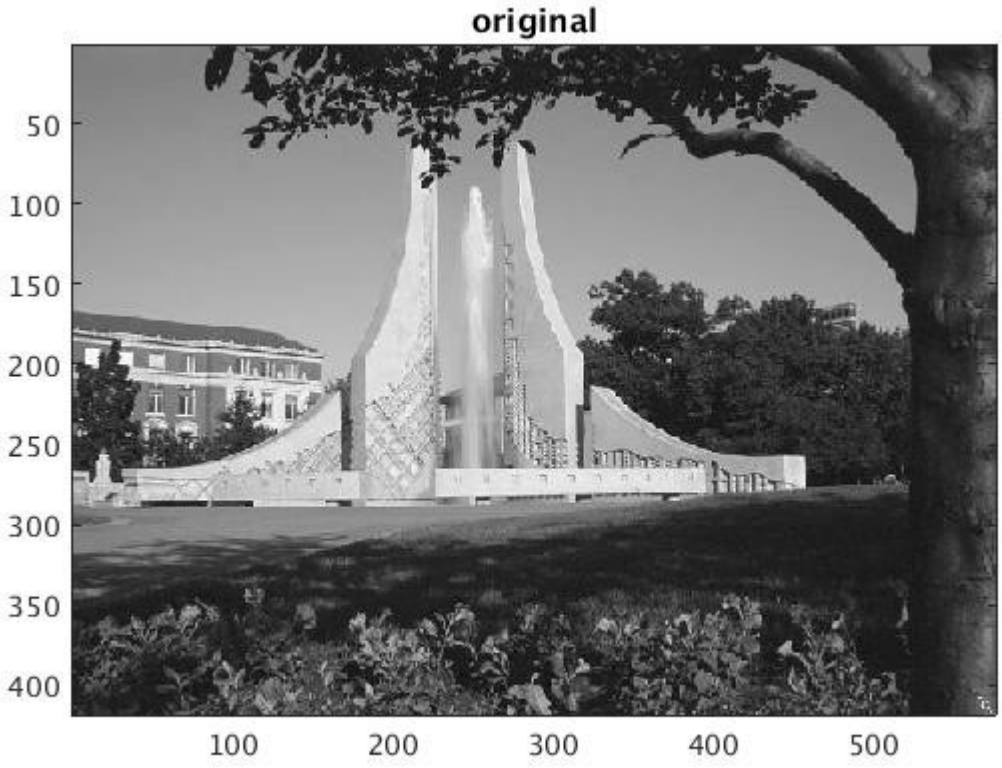
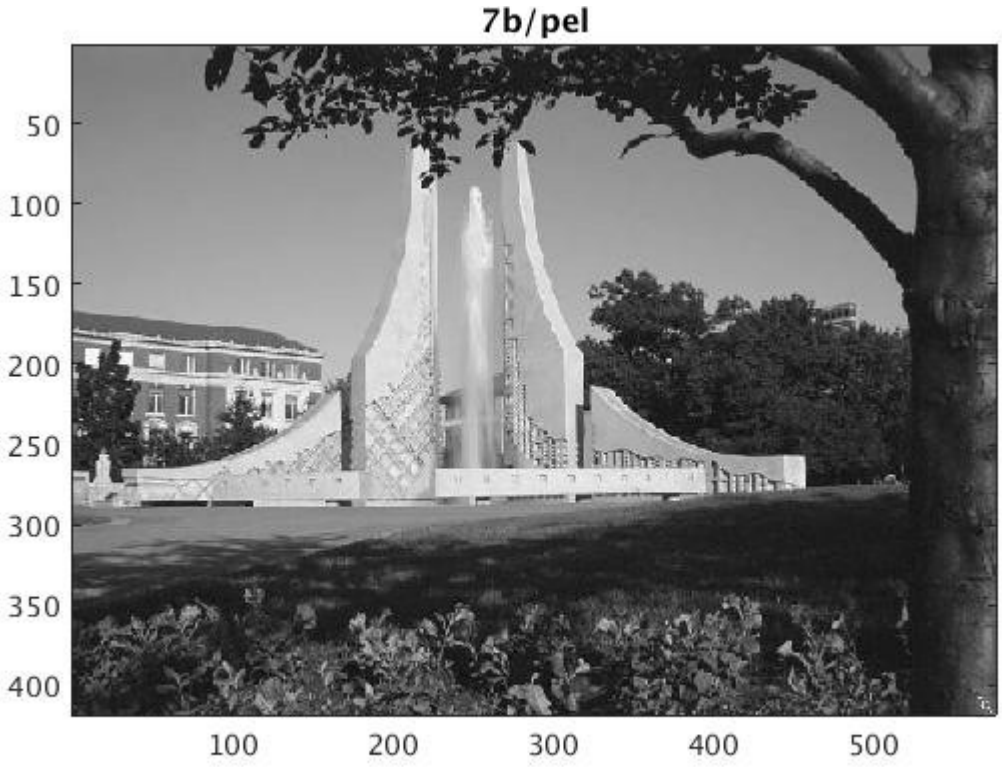
3.3

1) As the number of bits is lowered, there is more distortions due to the quantization error

2) 2b/pel

3)





4)

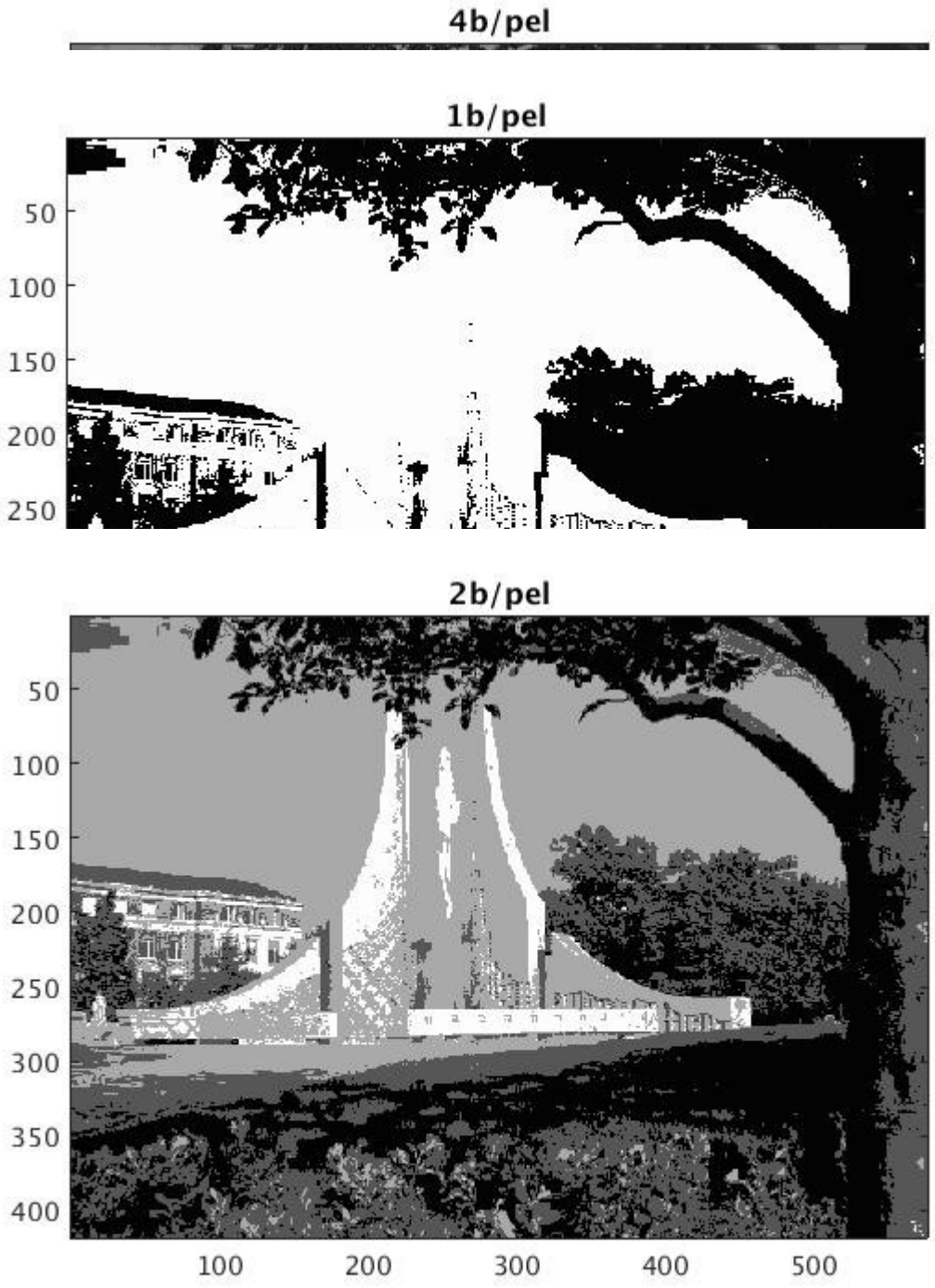
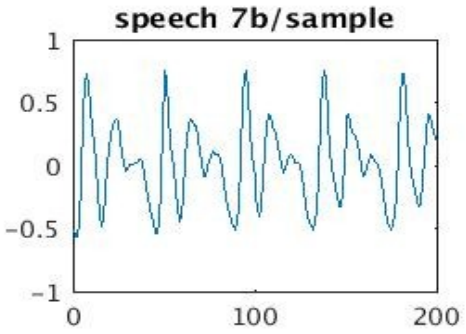
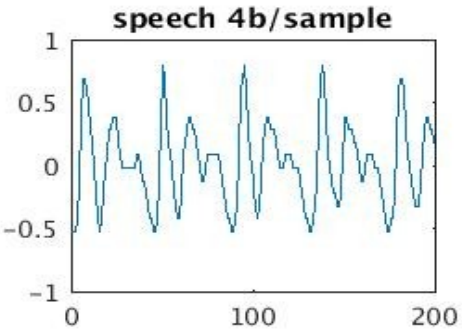


image with 7b/pel looks almost same as the original, image with 4b/pel looks almost same except the quantization error on the sky. Image with 2b/pel is not very good, image with 1b/pel only have black and white pixels.

3.4

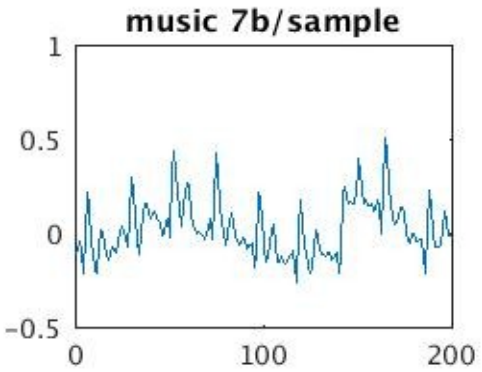


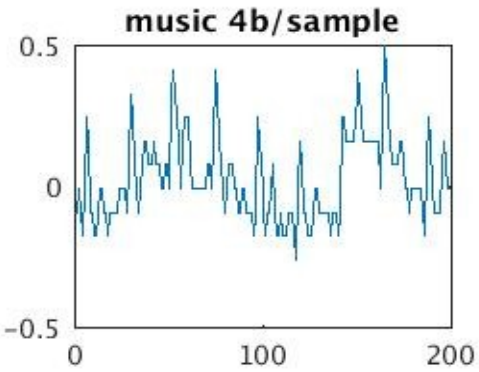


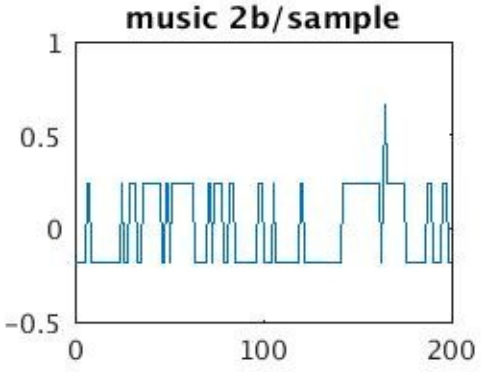
3.4.1

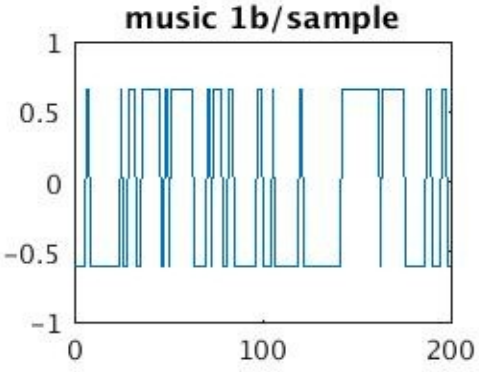
part 1

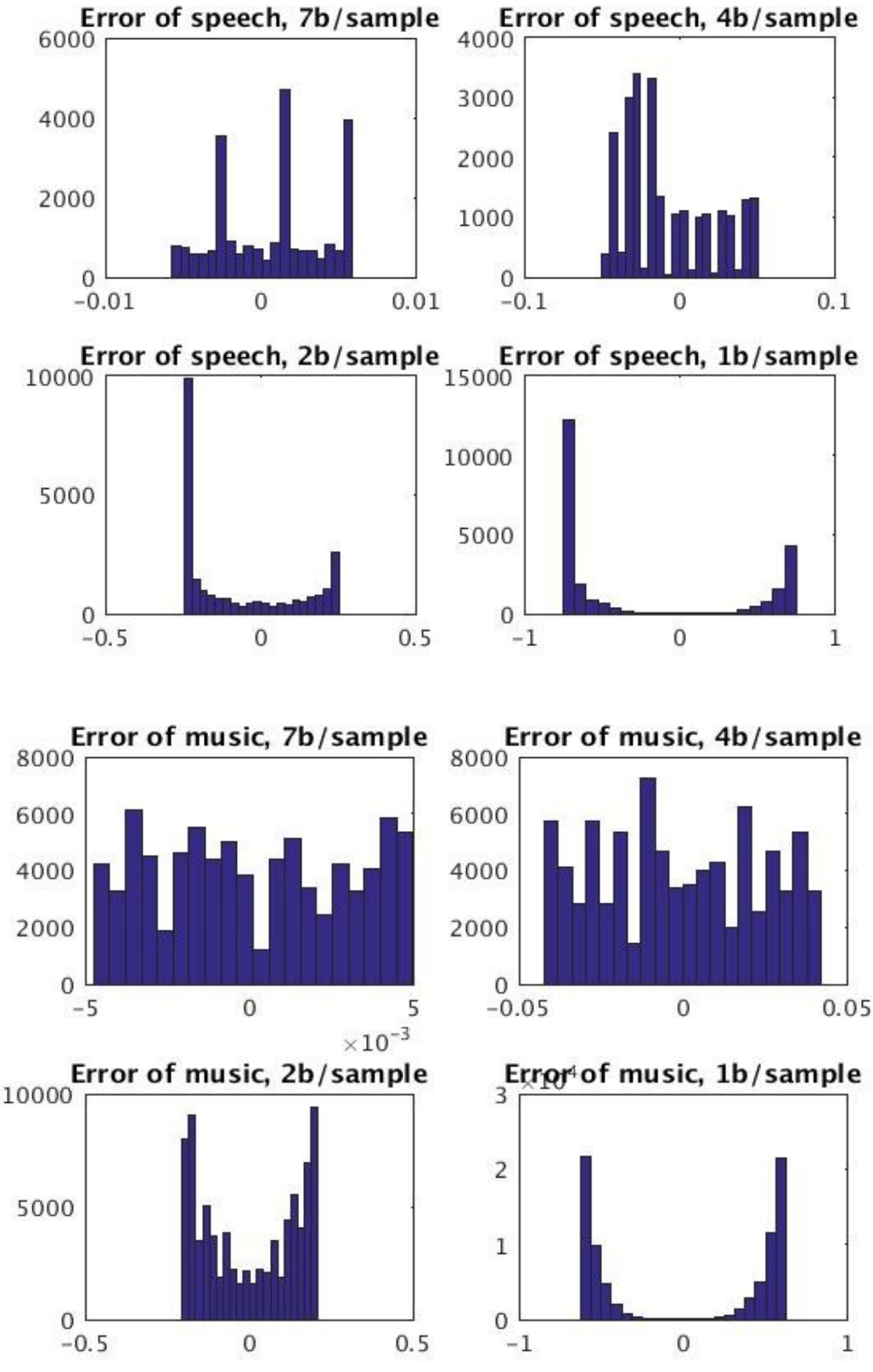
1)









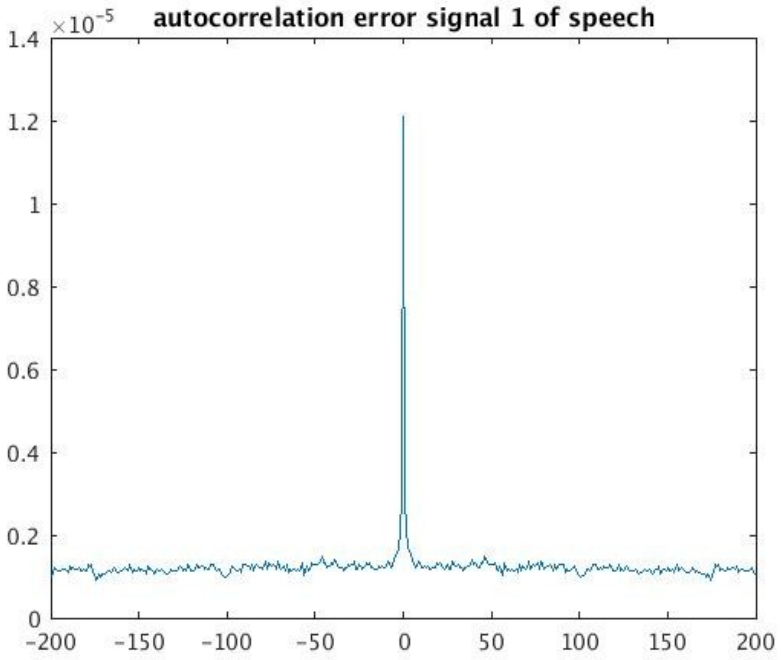

Error of speech, 7b/sample
6000
4000
2000
0
−0.01
0
0.01
Error of speech, 4b/sample
4000
3000
2000
1000
0
−0.1
0
0.1
Error of speech, 2b/sample
10000
5000
0
−0.5
0
0.5
Error of speech, 1b/sample
15000
10000
5000
0
−1
0
1
Error of music, 7b/sample
8000
6000
4000
2000
0
−5
0
5
×10^−3
Error of music, 4b/sample
8000
6000
4000
2000
0
−0.05
0
0.05
Error of music, 2b/sample
10000
5000
0
−0.5
0
0.5
Error of music, 1b/sample
×10^4
3
2
1
0
−1
0
1

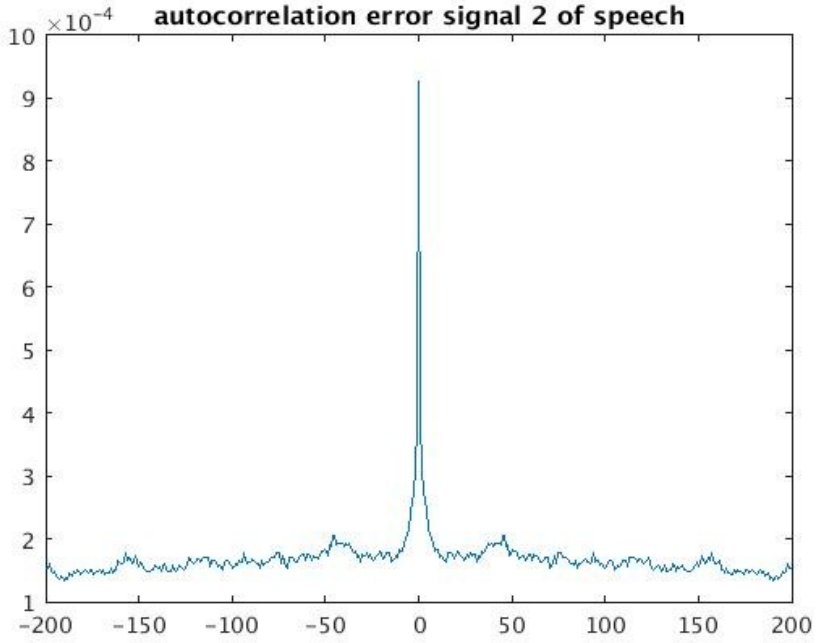
2) The more quantization levels, the narrower the distribution of error is.

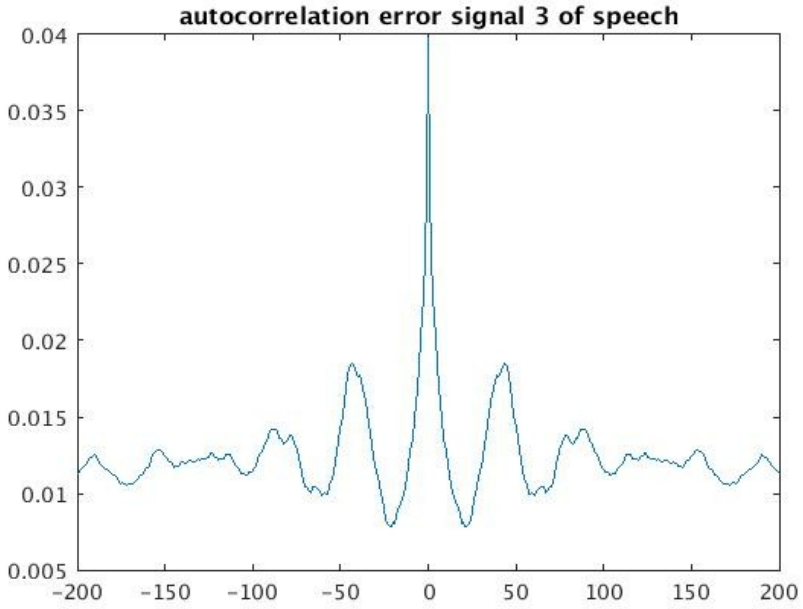
3) because the signal is not uniform

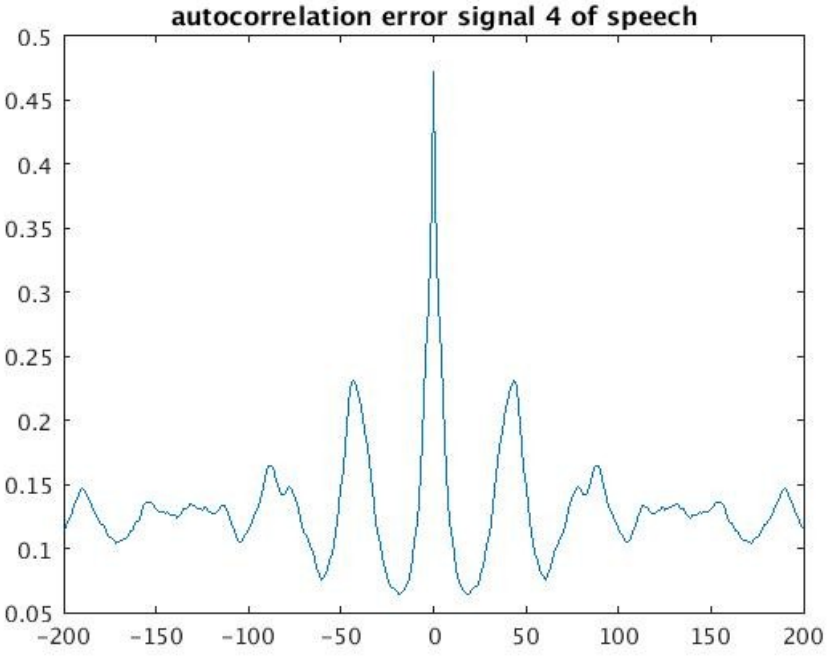
part 2

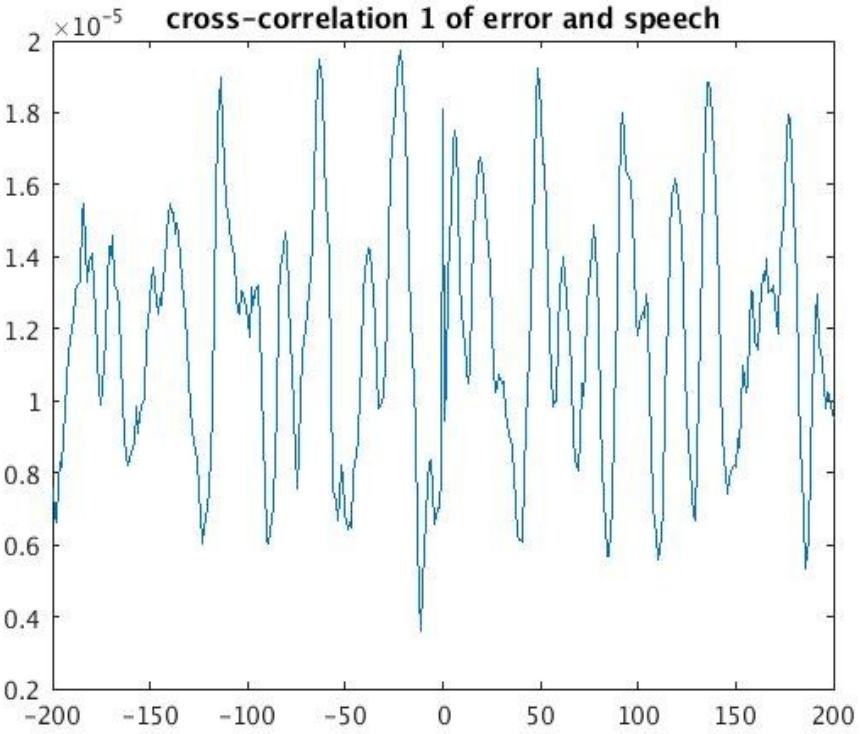
1)

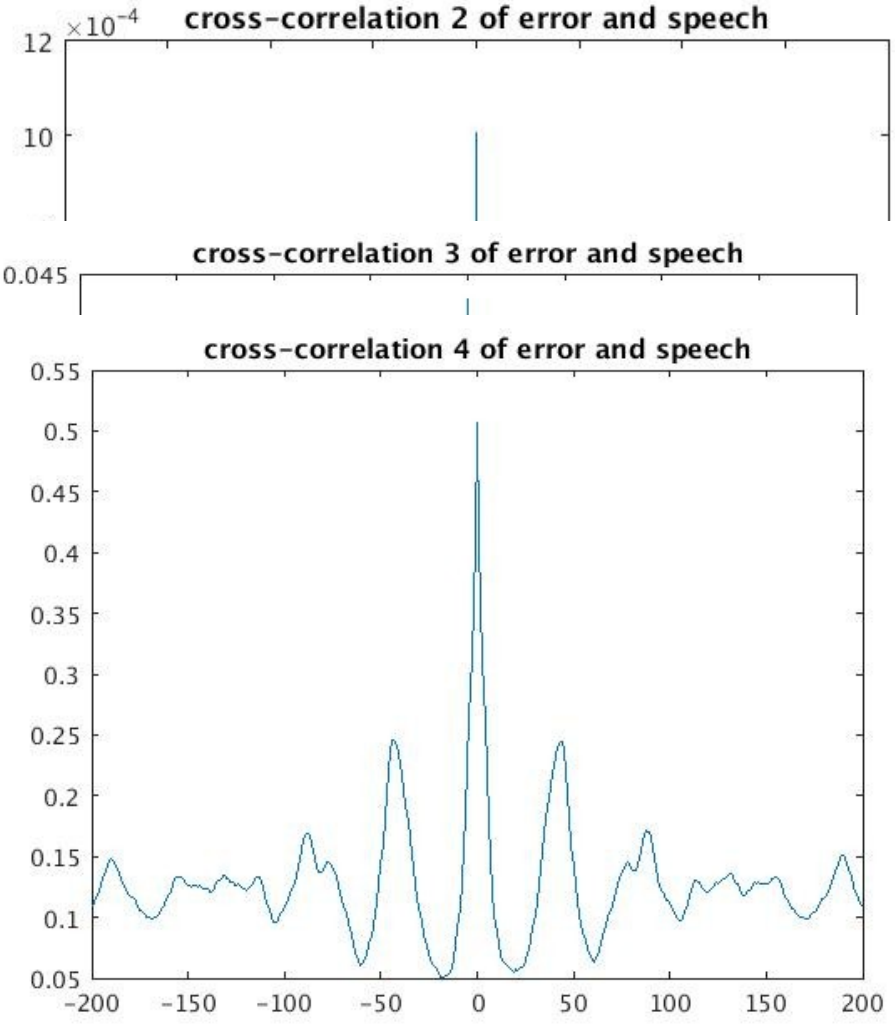





autocorrelation error signal 3 of speech
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
-200
-150
-100
-50
0
50
100
150
200


autocorrelation error signal 4 of speech
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
-200
-150
-100
-50
0
50
100
150
200


cross-correlation 1 of error and speech
×10^-5
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
-200
-150
-100
-50
0
50
100
150
200


cross-correlation 2 of error and speech
×10^-4
12
10
cross-correlation 3 of error and speech
0.045
cross-correlation 4 of error and speech
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
-200
-150
-100
-50
0
50
100
150
200

2) the

autocorrelation is influenced by the number of quantization levels. The samples in error signal appear not correlated with each other

3) The number of quantization levels influence the cross-correlation

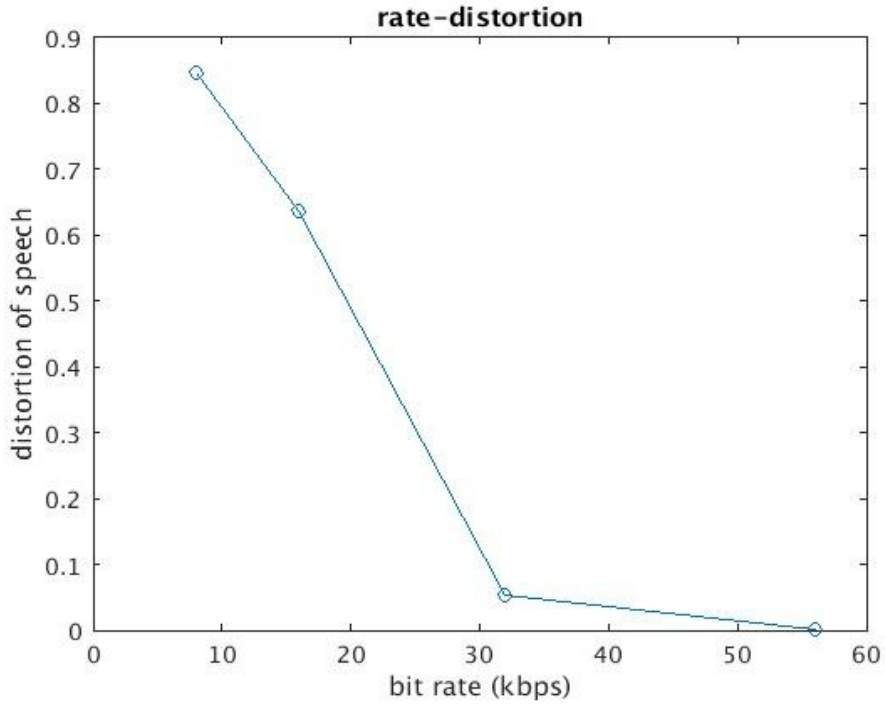
3.4.2

```
n = [7,4,2,1];
PSNR
```

PSNR =

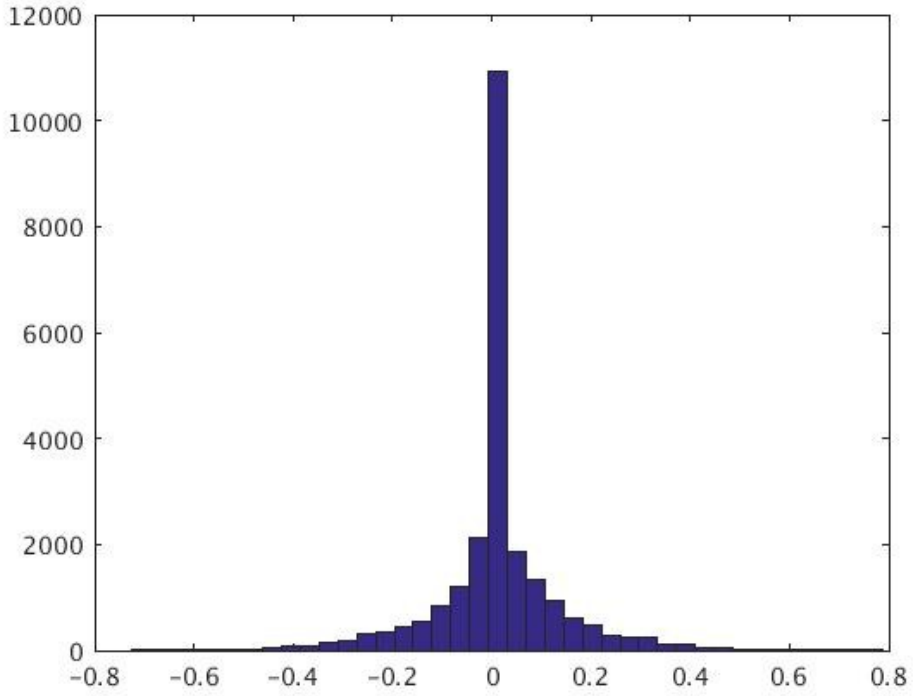
1.0e+03 *

1.3255 0.0184 0.0016 0.0012



3.5

1)



2) PSNR2 =

4.4310

PSNR is greater and Max-quantized signal is better than the uniform-quantized one.

3) if the speech signal is uniformly distributed, the two quantizers will be the same.

Because when it is uniformly distributed, the quantization levels of max quantizer is also uniformed, which is same as the uniform-quantizer's