Multimedia System

Report - Laboratory exercice n° 1

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Laboratory exercice n°1

Q 6 What would be the interpretation of the results Eyi that you would get without transposition? What dimensions would it be?

ym 8x479 double

Without the transposition:

Eyi 1x479 double 1 line of 479 colums

With transposition:

Eyi [0.1321,0.1275,0.0303,... 1x8 double

Mean values are computed on the columns.

Since Eyi is computed using the ym variable, and this variable is composed of 8 lines and 479 columns, if we don't use transposition, we are computing the mean value and will have a result of 479 columns, which is a lot and will take more time to be computed.

In the end, we have the same results with or without transposition, for example, I tried to compute SNRy with and without transposition, and in both cases I obtained 37.8906 dB.

Q 7 Using help, learn how to use the function MT02_huffman to generate Huffman coding table and how to use functions MT02_huff_enc, MT02_huff_dec for actual encoding and decoding of symbols generated by the quantizers based on the constructed coding tree. What is the structure of the coding table?

Here is the structure of the huffman coding table:

Lines:

- N lines: The first N lines refer to the N input symbols used from the input vector.
- Remaining: The remaining lines refer to the internodes.
- Last: The last line represents the root of the Huffman tree.

Columns:

- 1sr: Indexes of symbols or internodes
- 2nd: code of symbol
- 3rd: Probabilities
- 4th: Index of "dad" leave (0 if root)
- 5th: Index of left child
- 6th: Index of right child
- 7th: Length of huffman code
- 8th: huffman code

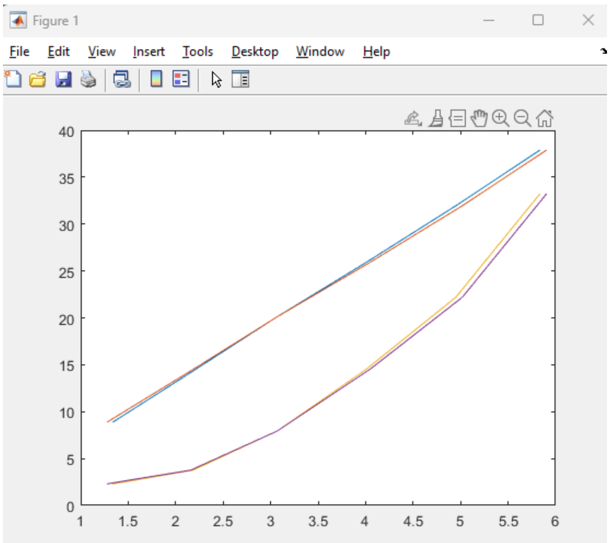
Comment sound p19 et p20

xq was never reconstructed so for a small entropy or a high entropy it is the same noise. However, since xr has been reconstructed, for a small entropy we can hear that the reconstruction is of poor quality and we can hear some kind of white noise.

Q8 - Screenshots

```
for channel=1:6
   H=channel;

   . % etc code
   .
   .
   . % etc code


     for i=1:Ndct
       tabley=[min(yi(i,:)):max(yi(i,:))]; % all output symbols from min to max
       pdfy=hist(yi(i,:),tabley)/nb; % pdf of output quantizer indices
       out_symb = find(pdfy>0); % observed output symbols
       HIy(i) = -pdfy(out_symb) * log2(pdfy(out_symb))'; % actual entropy of the
output symbols
   end
   HQuan(channel) = mean(HIy);
   SNRQ(channel) = SNRy;
   %step 4 and 5
   %encoder
   table=[min(yi(3,:)):max(yi(3,:))]; % all output symbols from min to max
   pdf=hist(yi(3,:),table)/nb; % pdf of output symbols

   [e, al, m] = MT02_huffman(table, pdf);% coding table and entropy
   str = MT02_huff_enc(yi(3, :), m, 1);% huffman encoding
   ydekod = MT02_huff_dec(str, m); % huffman decoding
   razl = sum(abs(ydekod - yi(3, :))); % difference (should be 0)

   HENC(channel) = e;
   SNRENC(channel) = al;
   m(:,1) = MT02_huffman(table, pdf);
   m = mean(m);
   huffVal(channel) = mean(m');

   xr=tr'*yq;
   xr=xr(:);
```

```
   xrk = zeros(Ndct, length(xr));
   for i=1:Ndct
       izdvoji=zeros(Ndct);
       izdvoji(i,i)=1;
       yqk=izdvoji*yq;
       xrk_matr = tr'*yqk;
       xrk(i,:) = xrk_matr(:);
   end
end

% display the results
plot(HQuan, SNRQ)
hold on
plot(HENC, SNRQ)
hold on
plot(HQuan, huffVal)
hold on
plot(HENC, huffVal)
hold off
```



We should obtain a result where the 2 lines are parallel. For a directly quantized signal, the SNR should be higher than when it was encoded. Otherwise, everything should remain the same, since using a quantizer allows us to improve the efficiency in terms of demand (but can lead to some errors).

Laboratory exercice n°2

Q1 - What are the output SNRs for direct quantization in comparison to SNRs after reconstruction using a predictive closed-loop coding structure?

Which vowel has the highest prediction gain, i.e. the largest actual increase in SQNR?

Is the predictive quantization error spectrally colored? Why?

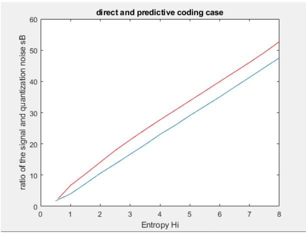
A	E	I	O	U	3
SNRs SNR(X) =47.688 dB SNR(E) =48.871 dB SNR(Xr) =59.488 dB	**SNRs** SNR(X) =47.534 dB SNR(E) =48.600 dB SNR(Xr) =52.716 dB	**SNRs** SNR(X) =47.655 dB SNR(E) =48.806 dB SNR(Xr) =54.875 dB	**SNRs** SNR(X) =47.469 dB SNR(E) =47.297 dB SNR(Xr) =64.558 dB	**SNRs** SNR(X) =47.765 dB SNR(E) =47.159 dB SNR(Xr) =67.656 dB	**SNRs** SNR(X) =47.215 dB SNR(E) =47.605 dB SNR(Xr) =56.946 dB
Quality increase SNR(Xr)-SNR(X) =11.801 dB	**Quality increase** SNR(Xr)-SNR(X) =5.182 dB	**Quality increase** SNR(Xr)-SNR(X) =7.220 dB	**Quality increase** SNR(Xr)-SNR(X) =17.089 dB	**Quality increase** SNR(Xr)-SNR(X) =19.891 dB	**Quality increase** SNR(Xr)-SNR(X) =9.731 dB
Prediction gain =10.631 dB	**Prediction gain** =4.129 dB	**Prediction gain** =6.073 dB	**Prediction gain** =17.262 dB	**Prediction gain** =20.501 dB	**Prediction gain** =9.347 dB

The vowel “U” has the highest prediction gain (20.501 dB).

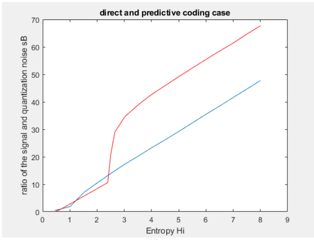
The predictive quantization error is not spectrally colored. Because all of the values (X - xrq) are equal to zeros, for all of the vowels.

Q2 What results (plots) do you get for different vowels?

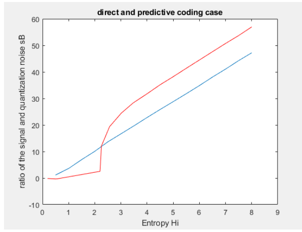
E



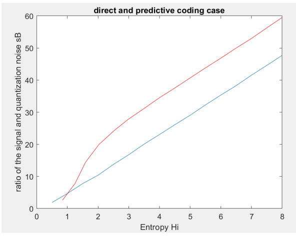
U



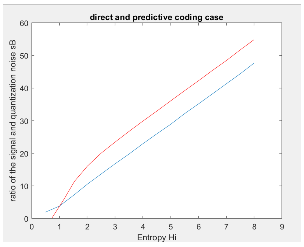
3



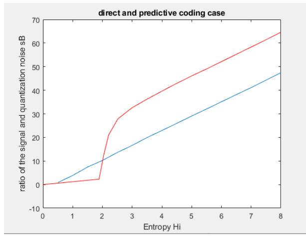
A



I



O



What is the relationship between the curves for direct quantization and for predictive ADPCM quantization?

We can see that for all of the vowels, in the end, the predictor (here in red) always has a higher value than the direct quantization. Which can lead us to think that using a predictor will be better since it will better reconstruct the signal in the end.

What happens to the direct quantization curve at very low entropies and what about the ADPCM curve?

For very low entropies, we can see that the predictor is not efficient, so when we are using these entropies values inferior 2, we should prefer the direct quantization to have a better reconstructed signal.

Q3 What is the quality of the reconstruction of a directly quantized image? How many different levels of gray can we expect with direct quantization?

The quality of reconstruction of a directly quantized image will be quite poor and the image would not be correctly grayscale, we will see some false contours appearing. We ca not exceed 250 levels of gray (parameters in code).

Q4 How are the signals (images) in the structure affected by the increase in the order of the predictor, and how by the increase in the output entropy? Describe in your own words.

Figure	increase in the order of the predictor	increase in the output entropy
xp	No changes	No changes
ec	p1: prediction error (everything is clear and gray) is low p2: error is worse than p1 but still acceptable (lines are blurry with a touch of white) p3: error is low (everything is gray)	prediction error is quite good for an entropy equal to 2, but for 1 & 4 there are a lot of dark & white spots.
ec-ecq	p1: prediction error of quantization is low(the image is disappearing) p2: prediction quantization error is quite worse than for p1 (shape are defined) p3 : prediction quantization error is high(shapes are well defined)	prediction error of quantization is decreasing with a higher entropy. The image is slowly disappearing when we are increasing the entropy.
x-xrq	p1: predictive quantization error is low (it is blurry & gray) p2: predictive quantization error is low (it is blurry & gray) p3 : predictive quantization error is high (shapes are	prediction error of quantization is decreasing with a higher entropy. The image is slowly disappearing when we are increasing the entropy.

	visible and in light grey)	
xrq	No changes	No changes
xq	No changes	For entropy equal to 1, the directly quantized signal is of poor quality, but for an entropy of 2 or 4 the image is well defined and there are no major changes.
x-xq	p1: direct quantization error is very high (but better than for p2) (the image is quite dark but not as much as for p2) p2: direct quantization error is high (the image too white & black) p3: direct quantization error is low (the image is in light gray)	for a small entropy (1 or 2) we will have a very high quantization error. But for an entropy equal to 4, the error is decreasing a lot and has become more acceptable.

Q5 For the 1st and 2nd order of the predictor, determine the required output entropy so that the predictive quantization error is within ± ½ LSB. Such a small quantization error means that rounding to the nearest integer would yield the original integer intensity values, i.e. that such coding is completely loss-less. You can see the error expressed in LSBs in Figure 8.

For the first order of predictors we will need an entropy of at least 1.5.
For the second order of predictors we will need an entropy of at least 2.