Final Project: Two-level Discrete 2-D Wavelet Transform

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CECS 627: Digital Image Processing

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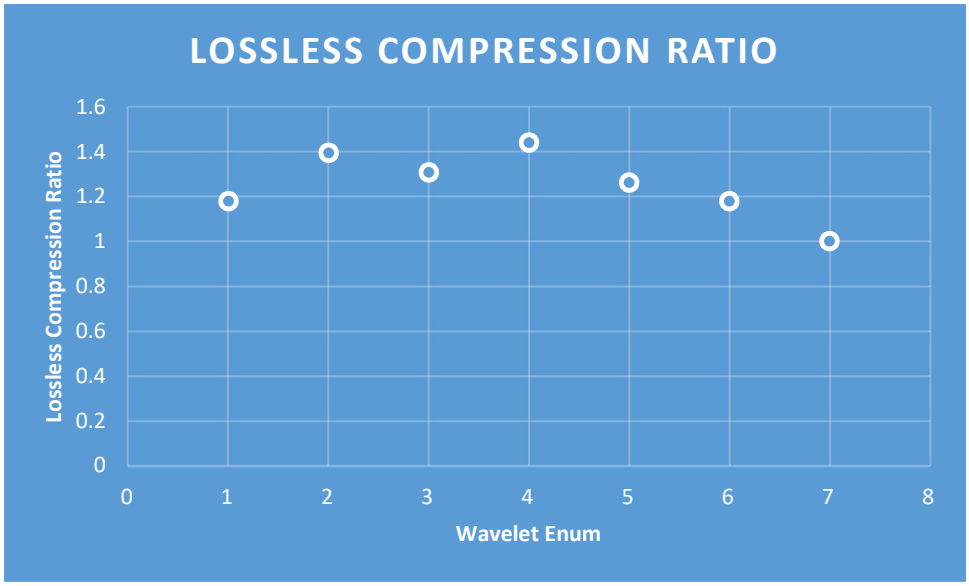
1 Results

Wavelet Name	Wavelet Enum	Lossless SNR	Lossless Compression Ratio	Lossy SNR	Lossy Compression Ratio
coif5	1	403.5385	1.1798	52.9706	12.4815
db1	2	701.1841	1.3949	45.9911	16.5504
db2	3	582.5093	1.3084	50.0388	16.1003
db4	4	563.2154	1.4411	52.2531	15.5909
db8	5	544.6446	1.2623	52.4808	14.4907
db16	6	547.9617	1.1801	53.1195	12.4438
db32	7	339.8129	1.0014	53.1832	9.3185

Deliverables

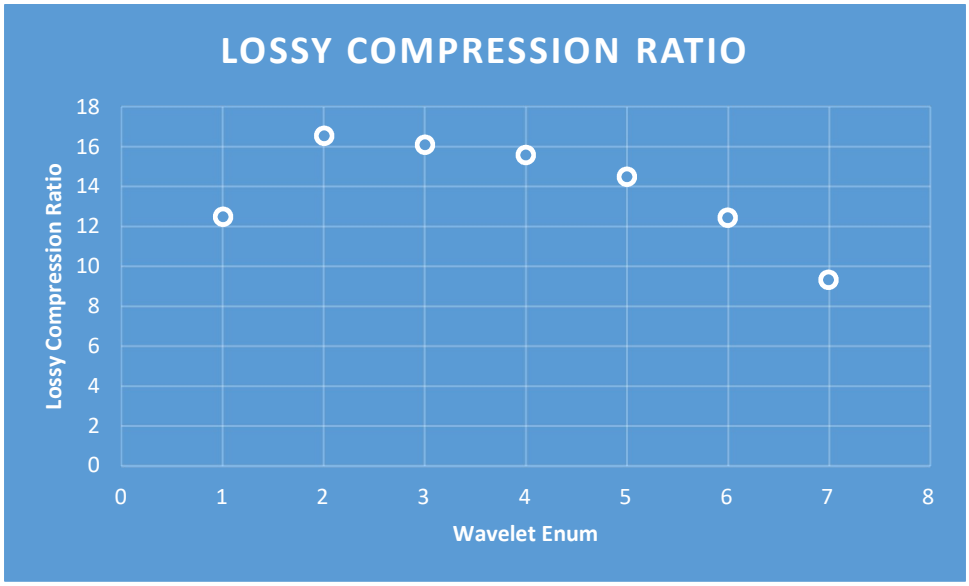
1.1 Plot Wavelet Name vs. Compression Ratio for the Lossless System

Please note: the wavelet enumeration numbers correspond to wavelet names shown in the results table.



1.2 Plot Wavelet name v.s Compression Ratio for Lossy System

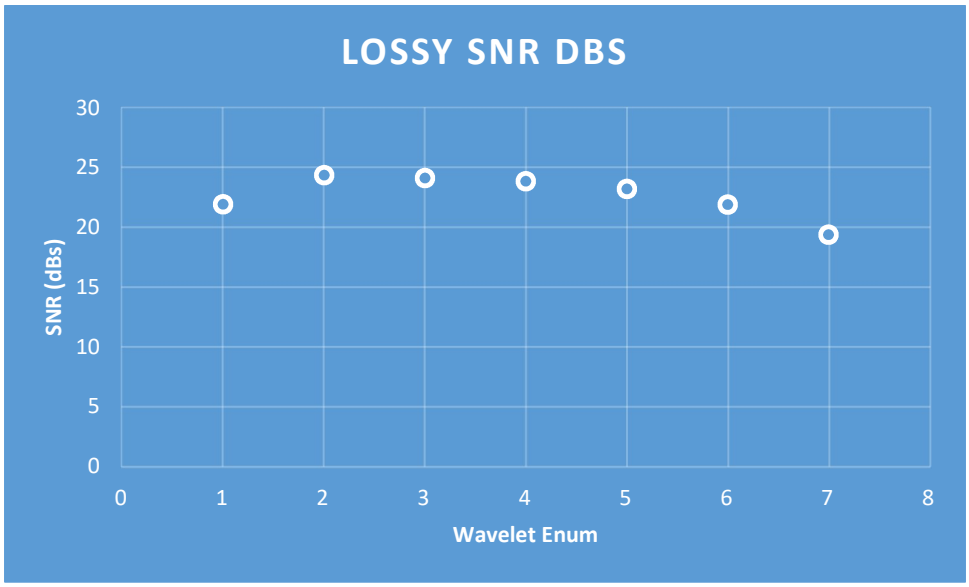
Please note: the wavelet enumeration numbers correspond to wavelet names shown in the results table.



1.3 Plot Wavelet name vs. SNR in dBs for Lossy System

I was unable to find the SNR function you used in your example. I found an equation online from here to compute SNR that gave analogous results to your example. Decibels were calculated by the following equation: snr_db = 20*log10(snr).

Wavelet Name	Lossy Compression Ratio	Lossy SNR DBs
coif5	12.4815	21.92533562
db1	16.5504	24.37616989
db2	16.1003	24.13667937
db4	15.5909	23.85742372
db8	14.4907	23.22178731
db16	12.4438	21.89906045
db32	9.3185	19.38692019



2 APPENDIX

2.1 MATLAB SCRIPT

```
wavelet_names = {'coif5', 'db1', 'db2', 'db4', 'db8', 'db16', 'db32'}

for wavelet_index = 1:length(wavelet_names)
    wavelet_name = wavelet_names{wavelet_index}
    [h0 h1 f0 f1] = wfilters(wavelet_name);

    % Get the image
    f = mat2gray(imread('lenna.jpg'));
    sz1=size(f);

    % Perform Single-level 2D WLT
    [LL LH HL HH] = dwt2(f, wavelet_name);
    sz2=size(LL);

    % Perform Two Level 2d WLT by transmofring quandrant LL
    [LL1 LH1 HL1 HH1] = dwt2(LL, wavelet_name);
    sz3 = size(LL1);

    % Reconstruct Lossless Image
    LL2 = idwt2(LL1, LH1, HL1, HH1, wavelet_name, sz2);
    lossless_g = idwt2(LL2, LH, HL, HH, wavelet_name, sz1);
    lossless_snr = 20*log(norm(f,'fro')/norm(f-lossless_g,'fro'))


    % Sum the histograms across the 7 output sub images
    h1=hist(reshape(LL1, size(LL1, 1) * size(LL1, 2), 1), 256);
    h2=hist(reshape(LH1, size(LH1, 1) * size(LH1, 2), 1), 256);
    h3=hist(reshape(HL1, size(HL1, 1) * size(HL1, 2), 1), 256);
    h4=hist(reshape(HH1, size(HH1, 1) * size(HH1, 2), 1), 256);
    h5=hist(reshape(LH, size(LH, 1) * size(LH, 2), 1), 256);
    h6=hist(reshape(HL, size(HL, 1) * size(HL, 2), 1), 256);
    h7=hist(reshape(HH, size(HH, 1) * size(HH, 2), 1), 256);
    h=h1+h2+h3+h4+h5+h6+h7;
    h_sum = sum(h);

    % Compute the entropy of the lossless image
    h = h / h_sum; e = 0; L2 = log(2) ; for i = 1:256 if h(i) > 0 e = e-
h(i)*log(h(i))/L2; end; end;

    % Compute the Compression Ratio
    lossless_compression_ratio = 8*512*512/(e*h_sum)

    % Reconstruct the lossy Image
    z1 = zeros(sz3);
    z2 = zeros(sz2);
    LL2 = idwt2(LL1, z1, z1, z1, wavelet_name, sz2);
    lossy_g = idwt2(LL2, z2, z2, z2, wavelet_name, sz1);
    lossy_snr = 20*log(norm(f,'fro')/norm(f-lossy_g,'fro'))
```

```
    % Compute the entropy of the lossy image
    h1_sum = sum(h1);
    h1 = h1 / h1_sum; e = 0; l2 = log(2); for i = 1:256 if h1(i) > 0 e = e -
h1(i)*log(h1(i))/L2; end; end;
    lossy_compression_ratio = 8*512*512/(e*h1_sum)
end
```

2.2 MATLAB OUTPUT

```
>> FinalProject


wavelet_names =


  1×7 cell array


    {'coif5'}    {'db1'}    {'db2'}    {'db4'}    {'db8'}    {'db16'}    {'db32'}




wavelet_name =


    'coif5'



lossless_snr =


   403.5385



lossless_compression_ratio =


    1.1798
```

```
lossy_snr =

   52.9706


lossy_compression_ratio =

   12.4815


wavelet_name =

    'db1'


lossless_snr =

  701.1841


lossless_compression_ratio =

    1.3949


lossy_snr =

   45.9911
```

lossy_compression_ratio =

16.5504

wavelet_name =

'db2'

lossless_snr =

582.5093

lossless_compression_ratio =

1.3084

lossy_snr =

50.0388

lossy_compression_ratio =

16.1003

wavelet_name =

'db4'

lossless_snr =

563.2154

lossless_compression_ratio =

1.4411

lossy_snr =

52.2531

lossy_compression_ratio =

15.5909

wavelet_name =

'db8'

lossless_snr =

544.6446

lossless_compression_ratio =

1.2623

lossy_snr =

52.4808

lossy_compression_ratio =

14.4907

wavelet_name =

'db16'

lossless_snr =

547.9617

lossless_compression_ratio =

1.1801

lossy_snr =

53.1195

lossy_compression_ratio =

12.4438

wavelet_name =

'db32'

lossless_snr =

339.8129

lossless_compression_ratio =

1.0014

lossy_snr =

53.1832

lossy_compression_ratio =

9.3185