EE7150 Computer Project VI
Image Compression (Chapter 8)
Due Date: Nov 1, 2021

1. **Image Entropy**

Write a program to compute the entropy estimates of an image [Eq. (8-7) in 4th Ed, Eq. (8.1-7) in 3rd Ed.]. Download the images of Figures 8.1(a), (b) and (c) [both Editions] and use your program to estimate the entropies. Compare your results with those given in Example 8.2 [both Editions] of the textbook.

2. **Huffman Coding:** Solve problems 8.9 and 8.10

8.9 Consider the simple 4×8, 8-bit image:

21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243

(a) Compute the entropy of the image.

(b) Compress the image using Huffman coding.

(c) Compute the compression achieved and the effectiveness of the Huffman coding.

(d)* Consider Huffman encoding pairs of pixels rather than individual pixels. That is, consider the image to be produced by the second extension of the zero-memory source that produced the original image. What is the entropy of the image when looked at as pairs of pixels?

(e) Consider coding the differences between adjacent pixels. What is the entropy of the new difference image? What does this tell us about compressing the image?

(f) Explain the entropy differences in (a), (d) and (e).

8.10 Using the Huffman code in Fig. 8.8, decode the encoded string 0101000001010111110100.

3. **Transform Coding**

a) Write a program to compute the information loss associated with the following transform coding schemes:

	Case 1	**Case 2**
Transform	Fourier	Cosine
Subimage Size	8 x 8	8 x 8
Bit Allocation	8-largest coding	8-largest coding

Download the image in Fig. 8.9 (a) [both Editions] and use the program to compare Cases 1 and 2. Quantify the loss of information in terms of root-mean-square (RMS) error [Eq. (8-10) in 4th Ed, Eq. (8.1-10) in 3rd Ed.] and mean-square signal-to-noise ratio (SNR_{ms}) [per Eq. (8-11) in 4th Ed, Eq. (8.1-11) in 3rd Ed.].

b) Gradually decrease the number of retained coefficients until the reconstruction error for Case 2 becomes objectionable. That is, try 7-largest, 6-largest, … etc. coding as the bit allocation method (see top of page-643 of 4th Ed. [bottom of Page-577 in 3rd Ed.] for explanation on *N-largest coding*).

4. **Wavelet Coding**

Compress the image of Fig. 8.9 (a) using the Haar-based DWT program used in Project-V. Use various scales while *truncating the detail coefficients* to achieve compression. Quantify the reconstruction error in terms of RMS error and SNR_{ms}, and compare both the computed error and wavelet-based compression performance to the transform coding results from Problem-2.