Image Processing (NYCU CS, Fall 2021) Programming Assignment #3 (due 1/7/2022)

The objective of this assignment is for you to experiment with the various components of a JPEG codec. Your implementation should include both an encoder and a decoder. The purpose is the experimentation, so do not attempt to implement a codec that can read/write real JPEG files. It is only required that your decoder can reconstruct an image compressed by your encoder.

There are many components within a JPEG codec. Basically, your codec should consist of components in all the three main blocks: Mapper, Quantizer, and Symbol Coder. Things that you can experiment with include:

- Block based transform coding: Different transforms, different block sizes, etc.
- Quantization of DCT coefficients: Different quantization schemes (zonal coding, threshold coding, etc.), scaling factor to adjust quality, etc.
- Predictive coding (between the DC coefficients of adjacent blocks): You can compare the results with and without the predictive coding.
- Run-length coding of the AC coefficients: You can compare the results with and without the run-length coding.
- Chromatic subsampling: Compare the results (including subjectively) with and without chromatic subsampling.
- Huffman coding: (Note: The Huffman code tables in the standard are designed for when all the previous components are implemented, so they might not be suitable for you here. The suggestion is that you can go ahead to use Huffman code generated for each individual image.)

There are many available examples on the Internet, even code samples. You are allowed to use or modify existing codes (give reference) for parts of your system, but you need to be able to modify them and do experiments with them. You can also existing library function or code for Huffman code.

Try to evaluate your results both objectively (using SNR or RMSE) and subjectively (using examples, preferred with zoomed-in details).

Start your experiments with gray-scale images. If you are successful at compress and reconstruct gray-scale images, then move on to color images. JPEG use the YCbCr color space for color images.

The following two tables are quantization tables for luminance (left) and chrominance (right) from the standard documents. To experiment with block sizes other than 8x8, you can just interpolate the tables to your desired size.

16	11	10	16	24	40	51	61
12	12	14	19	26	58	60	55
14	13	16	24	40	57	69	56
14	17	22	29	51	87	80	62
18	22	37	56	68	109	103	77
24	35	55	64	81	104	113	92
49	64	78	87	103	121	120	101
72	92	95	98	112	100	103	99

17	18	24	47	99	99	99	99
18	21	26	66	99	99	99	99
24	26	56	99	99	99	99	99
47	66	99	99	99	99	99	99
99	99	99	99	99	99	99	99
99	99	99	99	99	99	99	99
99	99	99	99	99	99	99	99
99	99	99	99	99	99	99	99

Use at least 4 images from those supplied with the second assignment for your experiments. In addition, it is encouraged that you also find some other types of images to experiment with, such as those with line drawings or text.

To avoid delaying the decision on your final grades, this assignment will carry only a 3-day grace period (i.e., up to 1/10).