Homework #3

Due. 5/04/2020 (Monday midnight)

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(Goal of Project)

Practicing Image Coding with Huffman coding, DPCM, Non-uniform Quantization (LLoyd-Max Method).

(Tools)

1. Huffman Code
2. Differential Pulse-Code Modulation (DPCM).
3. Lloyd-Max Non-uniform Quantization

(Description of Project)

1. Get a 8 bits(256 levels) grey level image which size is 256*256.

[Encoding]

2. Apply DPCM to get the error values, $e = g - g^*$ for each pixel in raster scan order (from Top-Left to Bottom-right). Then, g is original pixel value (0 to 255), and g^* is the estimated pixel value from following DPCM equation.

$$g^*(i,j) = \frac{1}{4}[g(i-1,j) + g(i-1,j-1) + g(i,j-1) + g(i+1,j-1)]$$

for $i = 1,...,254, j = 1,....255$

$$g^*(0,j) = g(0,j),\ g^*(i,0) = g(i,0),\ g^*(255,j) = \frac{1}{3}[g(254,j-1) + g(254,j) + g(255,j-1)]$$

3. Draw probability density function for error values e. Then, by using Lloyd-Max method, take 64 levels non-uniform quantization for error values (-255 to +255) and get 64 quantized error values e^*.
4. Construct Huffman Code table for each 64 quantized error values e^* by calculating their probabilities using pdf drawn in step3.
5. Get the encoded code stream for e^* of whole image in raster scan order.

[Decoding]

6. From the encoded code stream for e^*, decode and reconstruct the original pixel value g by following equations.

   $\hat{g}(i,j) = g^*(i,j) + e^*(i,j)$, where $g^*(i,j)$ can be calculated as same as in step2 in raster scan order.

7. Calculate PSNR between original image g and reconstructed image $\hat{g}$. And discuss the results.