JPEG Encoder (Lossy-Baseline)

In the mid-1980s, joint work by the members of the International Telecommunication Union (Telegraphy section) (ITU-T) and the International Standards Organisation (ISO) which are known also as the Joint Photographic Experts Group (JPEG) led to a standardisation for compression of greyscale and colour still images. (book1)

JPEG Endocer general steps are:

Convert image to YUV space

Divide image into 8x8 blocks

Conversion to Frequency Domain (DCT)

Quantization

Entropy Coding

- Zig-Zag Scan Order

- Run Length Code

- Huffman Coding

Write to a binary file

- Headers

Convert Image to YUV space

JPEG standard uses YUV(YCbCr) color space. YUV color space is adopted from the human visual system. Human eye is less sensitive to colors than luminance. JPEG standard uses the formulas :

Y = 0.299 R + 0.587 G + 0.114 B  
Cb = - 0.1687 R - 0.3313 G + 0.5 B + 128  
Cr = 0.5 R - 0.4187 G - 0.0813 B + 128

The standard also uses zero shifting for pixel values. After converting image to YUV space, 2P p=level is subtracted from original values. In our case p is 8 than 128 is subtracted from all pixel values. This changes the scale of the byte values from 0…255 to –128…127. Thus, the

average value over a large set of pixels will tend towards zero.

Divide image into 8x8 blocks

Neighboring pixel has more similar statistical correlation than the whole image. Thinking this paradigm, JPEG standard divides image into 8x8 blocks. Blocks begin at the upper left part of the image, and are created going towards the lower right.

Conversion to Frequency Domain (DCT)

Human visual system is less sensitive to higher frequencies. In the standard, each image block is converted to Frequency Domain. At this point, FFT can be used, but the standard advices using DCT, which is faster than FFT, and also easier to work, due to the working real numbers instead of complex numbers.



Quantization

The quantization allows different weighting to be applied according to the human **psychovisual**  system to a coefficient of the frequency.(book1). Although JPEG standard is defining the standard quantization tables both for luminance and chrominance channels. But there are too many quantization tables, which are slightly differs from each other. (link)

Figures

Entropy Coding

- Zig-Zag Scan Order: Zig-Zag scan groups neighboring pixels in array and prepares the coefficients for entropy coding. The JPEG standard defines the scan order in Annex K.

- Run Length Code: RLC process computes hoe many times is repeating the each non-zero coefficients in zig-zag scan order.

- Huffman Coding: Huffman coding tables (table-1:3) are defined the JPEG Standard Annex-K. Each DC coefficient is coded differentially with the previous DC coefficient using first for the size (Table-1) and second the amplitude (Table-2). Each non-zero ac coefficient and run times are coded with variable length, using table-3 for run and size for run-length coded sequence.