

JPEG “Joint Photographic Experts Group”

JPEG is an image compression standard that was developed by the “Joint Photographic Experts Group”. JPEG was formally accepted as an international standard in 1992. It employs a transform coding method using the DCT (Discrete Cosine Transform) to yield the spatial domain into the frequency domain.

Progressive Image compression

- Progressive compression is an attractive choice when compressed images are transmitted over a communications line and are decompressed and viewed in real time. When such an image is received and is decompressed, the decoder can very quickly display the entire image in a low-quality format, and improve the display quality as more and more of the image is being received and decompressed.
- Progressive image compression is like imagine that the encoder compresses the most important image information first, then compresses less important information and appends it to the compressed stream, and so on. This explains why all progressive image compression methods have a natural lossy option; simply stop compressing at a certain point.
- Progressive image compression, in connection with JPEG. JPEG uses the DCT to break the image up into its spatial frequency components, and it compresses the low-frequency components first. The decoder can therefore display these parts quickly, and it is these low-frequency parts that contain the principal image information. The high-frequency parts contain image details. Thus, JPEG encodes spatial frequency data progressively.

JPEG Compression Modes

The JPEG standard defined four compression modes: Hierarchical, Progressive, Sequential and lossless. Figure 0 shows the relationship of major JPEG compression modes and encoding processes.

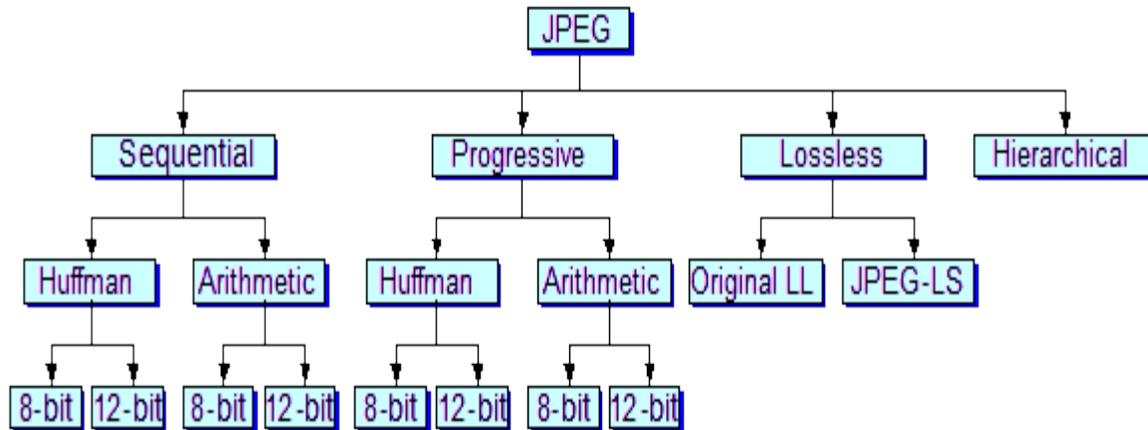
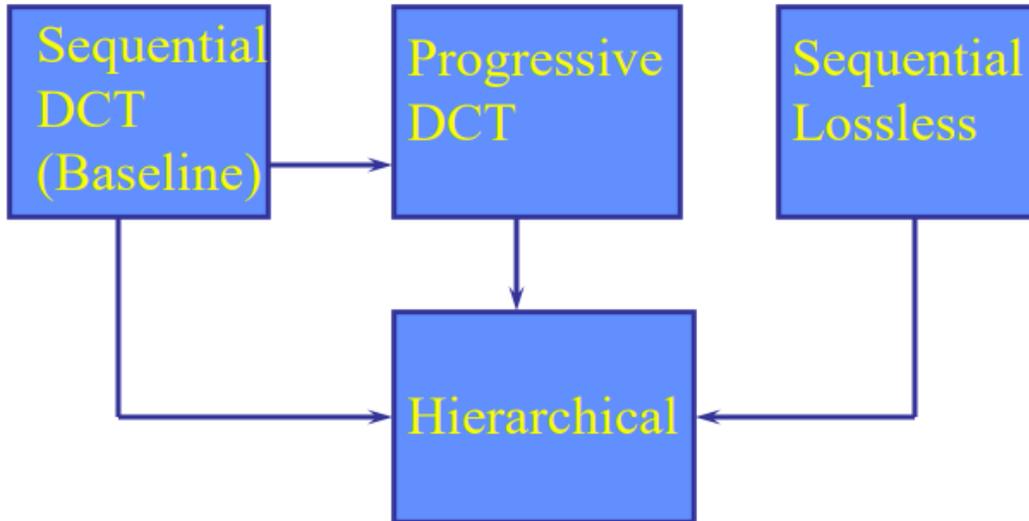


Figure . JPEG Operation Modes

JPEG 4 Compression Modes •

1. Sequential DCT based (Lossy)
2. Progressive DCT based (Lossy)
3. Sequential lossless, DPCM based
4. Hierarchical



1. **Sequential:** Sequential-mode images are encoded from top to bottom. Sequential mode supports sample data with 8 and 12 bits of precision.

- Image components are compressed either individually or in groups (by interleaving).
- One pass operation.
- “Baseline System”: A restricted mode, that must be included in any decoder.
- Color Components Interleaving is done to save buffer size.

2. **Progressive:** In progressive JPEG images, components are encoded in multiple scans.

A sequence of “scans”, each codes a part of the quantized DCT coefficients data.

• Two ways of doing this:

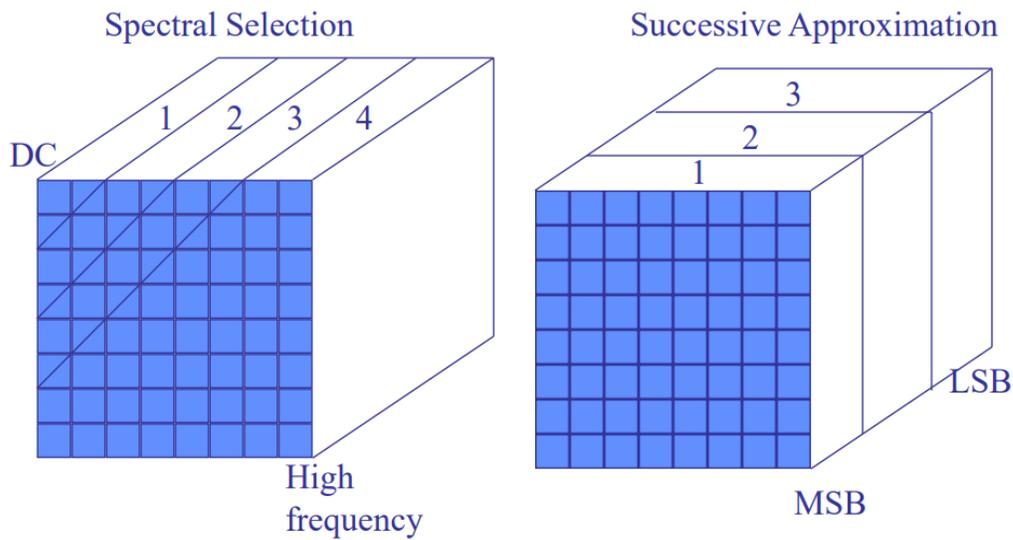
- **Spectral selection:** coeff. are grouped into spectral bands, and lower-frequency bands sent first. Takes advantage of the “spectral” (spatial frequency spectrum) characteristics of the DCT coefficients: higher AC components provide detail information.

Scan 1: Encode DC and first few AC components, e.g., AC1, AC2.
Scan 2: Encode a few more AC components, e.g., AC3, AC4, AC5.
...
Scan k: Encode the last few ACs, e.g., AC61, AC62, AC63.

– **Successive Approximation:** Instead of gradually encoding spectral bands, all DCT coefficients are encoded simultaneously but with their most significant bits (MSBs) first.

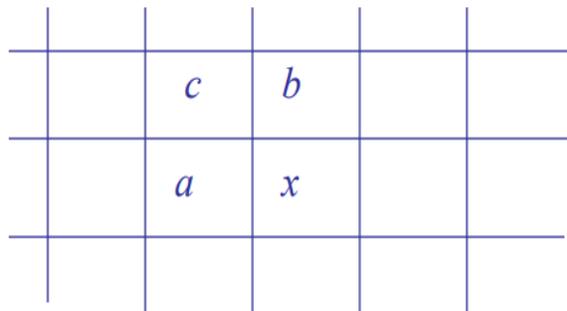
Scan 1: Encode the first few MSBs, e.g., Bits 7, 6, 5, 4.
Scan 2: Encode a few more less significant bits, e.g., Bit 3.
...
Scan m: Encode the least significant bit (LSB), Bit 0

- Note the top-left corner entry with the rather large magnitude. This is the DC coefficient (also called the constant component), which defines the basic hue for the entire block. (also called the alternating components)



3. **Lossless:** preserves exact, original image, small compression ratio, less use
 Reconstructed neighbors (a,b,c) are used to predict current sample x. Prediction
 equation selected from 8 options:

none, a , b , c , $a+b-c$, $a-(b-c)/2$, $b-(a-c)/2$, $(a+b)/2$



4. **Hierarchical:** JPEG is a super-progressive mode in which the image is broken
 down into a number of subimages called frames. A frame is a collection of one
 or more scans. In hierarchical mode, the first frame creates a low-resolution
 version of image. The remaining frames refine the image by increasing the
 resolution. JPEG is a sophisticated lossy/lossless compression method for color or
 grayscale still images (not videos). It does not handle bi-level (black and white)

images very well. It also works best on continuous-tone images, where adjacent pixels have similar colors.

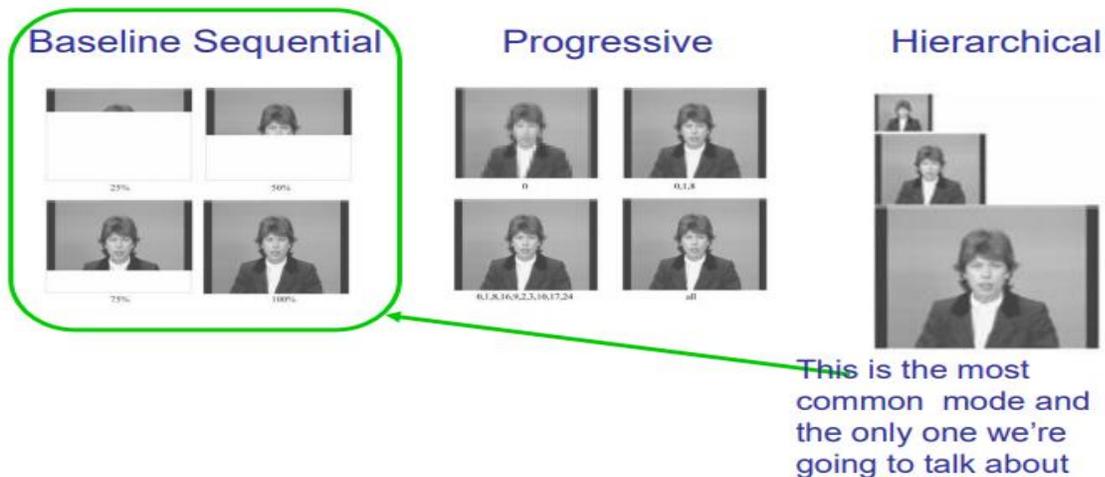
Hierarchical Mode (Cont'd)

- Useful for multi-resolution requirements :



JPEG Modes

- Three “lossy” modes of operation:



JPEG Compression: