

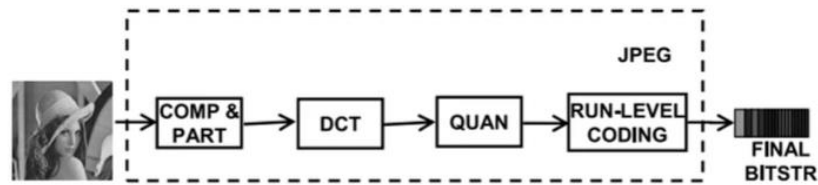
❑ Limitations of JPEG Standard

- Low bit-rate compression: JPEG offers an excellent quality at high and mid bit-rates. However, the quality is unacceptable at low bit-rates (e.g. below 0.25 bpp)
- Lossless and lossy compression: JPEG cannot provide a superior performance at lossless and lossy compression in a single code-stream.
- Transmission in noisy environments: the current JPEG standard provides some resynchronization markers, but the quality still degrades when bit-errors are encountered.
- Different types of still images: JPEG was optimized for natural images. Its performance on computer generated images and bi-level (text) images is poor.

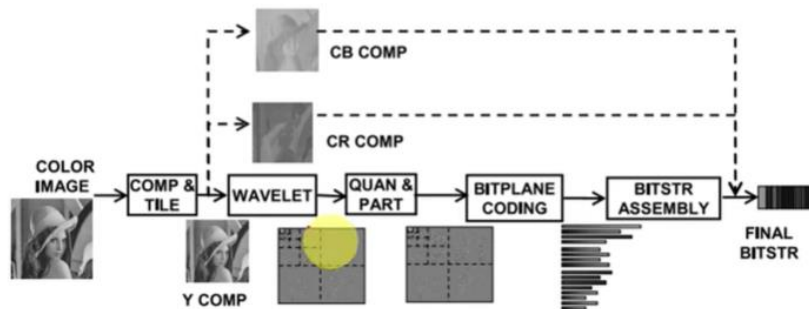
❑ JPEG 2000

- JPEG 2000 is based on the DWT(Discrete Wavelet Transform). DWT decomposes the image using functions called wavelets.
- The main advantage of wavelet is that it offers both time and frequency information.
- The idea here is to have more localized analysis of the information which is not possible using cosine functions whose spatial supports are identical to the data.
- JPEG 2000 distinguishes itself from JPEG compression standards not only by virtue of its higher compression ratios, but also by its many new functionalities.
- The most noticeable among them is its scalability. From a compressed JPEG 2000 bitstream, it is possible to extract a subset of the bitstream that decodes to an image of variable quality and resolution.





Operation flow of JPEG



Flowchart for JPEG 2000

❑ What is Wavelet Transform ?

- Wavelets are functions that are defined in time as well as in frequency around a certain point.
- Wavelet is a localized image transform. Because of localized process LF and HF components are scanned row wise as well as column wise.
- Wavelet based transforms are mathematical tools which are used to extract information from images. A significant benefit it has over Fourier transforms is temporal(time) resolution which signifies that it can capture both frequency and location information of the images.
- Wavelet transform can be viewed as the projection of a signal into a set of basis functions named wavelets. Such basis functions offer localization in the frequency domain.
- The wavelet transform is designed in such a way that we get good frequency resolution for low frequency components (average intensity values of image) and high temporal resolution for high frequency components (edges of image).

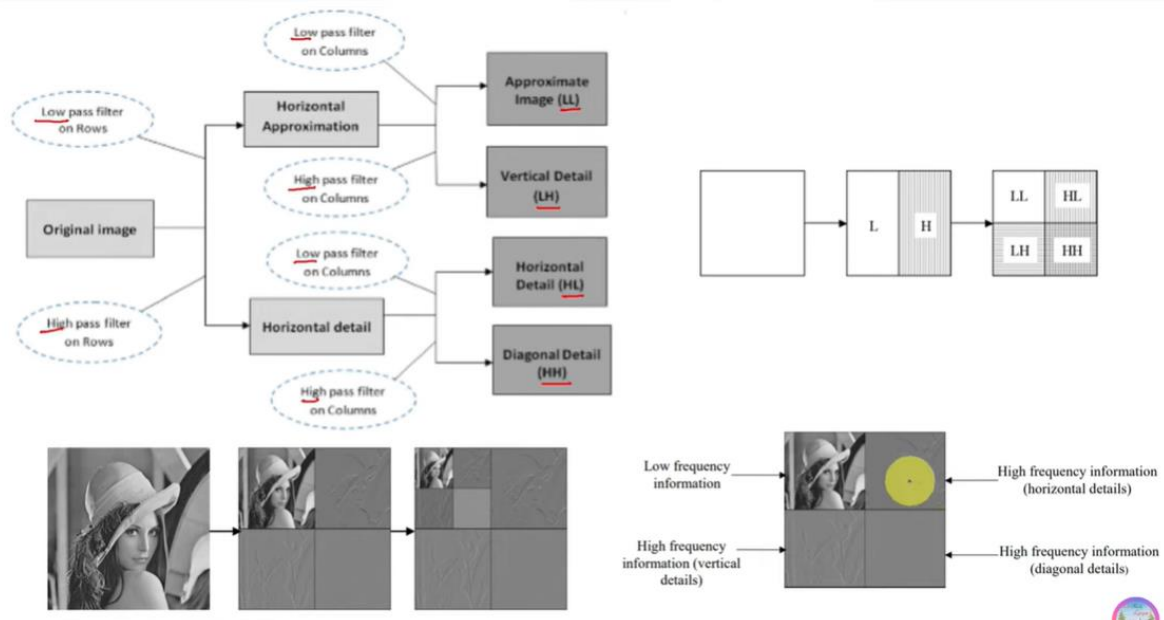
❑ Steps of Wavelet Transform

Step1: Start with a mother wavelet such as Haar, Morlet, Daubechies etc. The image is then translated into shifted and scaled versions of this mother wavelet. First original image have to been passed through high pass filter and low pass filter by applying filter on each row. We know when we apply LPF we get approximation and when we apply HPF we get the details.

Step2: Now to the horizontal approximation, we again apply LPF and HPF to the columns. Hence we get the approximate image (LL) and vertical detail of the horizontal approximation(LH).

Step3: Next we apply LPF and HPF to the horizontal detail. Hence we get horizontal detail of the image (HL) and the diagonal detail of the image (HH).

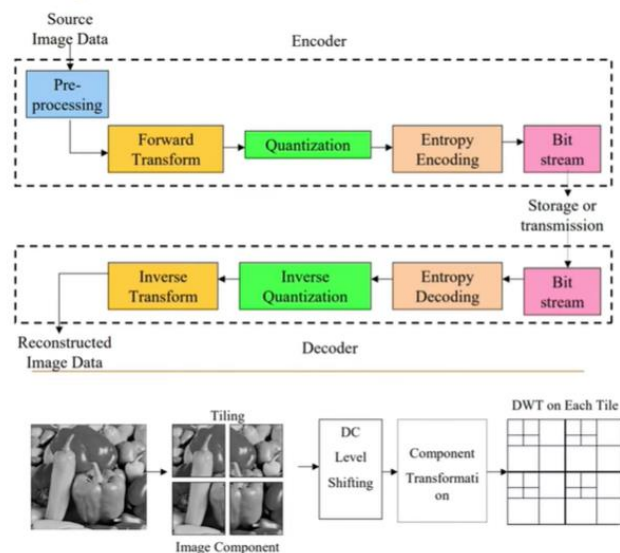
If the 3 detail sub-signals i.e. LH, HL and HH are small, they can be assumed to be zero, without any significant change in the image. Hence large compression can be achieved using wavelet transform.



❑ Features of JPEG 2000

- **Lossless and lossy compression:** the standard provides lossy compression with a superior performance at low bit-rates. It also provides lossless compression with progressive decoding. Applications such as digital libraries/databases and medical imagery can benefit from this feature.
- **Protective image security:** the open architecture of the JPEG2000 standard makes easy the use of protection techniques of digital images such as watermarking, labeling, stamping or encryption.
- **Region-of-interest coding:** in this mode, regions of interest (ROI's) can be defined. These ROI's can be encoded and transmitted with better quality than the rest of the image.
- **Robustness to bit errors:** the standard incorporate a set of error resilient tools to make the bit-stream more robust to transmission errors.

❑ Block diagram of JPEG 2000



Sr. No:	Parameter	JPEG	JPEG 2000
1.	Definition	It was created by Joint Photographic Expert Group in 1986.	It was created by JPEG in year 2000 and is a new standard.
2.	Lossy/Lossless	JPEG uses lossy compression.	JPEG 2000 offers both lossless & lossy compression.
3.	Complexity	JPEG codec has low complexity.	JPEG 2000 codec is highly complex.
4.	Resolution and Quality	JPEG gives single resolution and single quality.	JPEG 2000 gives multiple resolution and full quality scalability.
5.	Compression ratio	JPEG gives C_R around 10 to 20.	JPEG 2000 can give C_R around 30 to 200.
6.	Algorithms/ Techniques used	JPEG uses DCT.	JPEG 2000 uses DWT.
7.	Computation	It requires less computational complexity and computation time is less.	It requires more computational complexity and computation time is also more.
8.	Image Quality	Blocking artifacts are present in the image and regions of interest can also be not selected.	Blocking artifacts are not present in the image, image quality is very good and regions of interest can also be selected for quality.
9.	Applications	JPEG is used widely on World Wide Web and in digital cameras.	JPEG 2000 is widely in use in the medical and wireless multimedia arenas. Most diagnostic imagery, such as MRI, CT scans, and X-rays, are encoded as JPEG 2000.
10.	File extension	IPEG/IPG.	I2K/IP2/ IPX.

❑ Comparison



JPEG (DCT based)

JPEG-2000 (Wavelet based)

❑ Comparison

JPEG-2000(1.83KB)



JPEG (6.21 KB)



Original(979 KB)