JPEG 2000 Overview

- Wavelet decomposition based compression standard for still images

- Intended to provide rate distortion and subjective image quality performance superior to existing standards

- Also, to provide additional features and functionalities:
  - Lossless and lossy coding
  - Progressive transmission by pixel accuracy and by resolution
  - Robustness to bit errors
  - Region of interest (ROI) coding
  - Internet security
In JPEG2000, the encoding procedure is as follows:

- The source image is decomposed into components.
- The image and its components are decomposed into rectangular tiles. The tile-component is the basic unit of the original or reconstructed image.

- The encoding can be done in such a way, so that certain ROI's can be coded in a higher quality than the background.
- Markers are added in the bitstream to allow error resilience.
- The codestream has a main header at the beginning that describes the original image and the various decomposition and coding styles that are used to locate, extract, decode and reconstruct the image with the desired resolution, fidelity, region of interest and other characteristics.
- The optional file format describes the meaning of the image and its components in the context of the application.

It should be noted here that the basic encoding engine of JPEG2000 is based on EBCOT (Embedded Block Coding with Optimized Truncation of the embedded bitstreams) algorithm.

![Diagram](image)

**Fig. 1.** Block diagrams of the JPEG2000 (a) encoder and (b) decoder.

![Diagram](image)

**Fig. 1a.** Tiling, DC level shifting and DWT of each image tile component.
Will JPEG 2000 replace JPEG?
One potential drawback is the increased complexity.
Compressive Data Hiding for Color Image Coding

Wavelet-based approach that can be applied as pre-processing step of other wavelet-type methods for coding still color images (e.g., SPIHT: Set Partitioning in Hierarchical Trees, an extension of EZW approach).

Basic idea: Hide color information into wavelet subbands of the luminance wavelet decomposition. Then, code the resulting grayscale image using existing approaches.
Data hiding principle:

Insert data into an image so that the image remains perceptually unaltered.

"Watermarking" procedure

The operation must be reversible so that the hidden data be recoverable from the "watermarked" image.
Compressive Data Hiding

Embedding steps

(1) The color image $X[n_1, n_2]$ is split into its three color components in the YIQ color space.

(2) The luminance $Y$ undergoes a multiresolution-like wavelet decomposition:

$Y \xrightarrow{DWT} (Y_{LL}, Y_{HH}, Y_{HL}, Y_{LH})$

$Y_{HL} \xrightarrow{DWT} (Y_{ll,HL}, Y_{hh,HL}, Y_{hl,HL}, Y_{lh,HL})$

$Y_{LH} \xrightarrow{DWT} (Y_{ll,LH}, Y_{hh,LH}, Y_{hl,LH}, Y_{lh,LH})$

(3) The chrominance components $I$ and $Q$ undergo a two-level wavelet decomposition and only the “lowpass” subbands at the coarsest resolution $I_{2LL}$ and $Q_{2LL}$ are kept.

(4) $I_{2LL}$ and $Q_{2LL}$ are normalized to the energy of $Y_{ll,HL}$ and $Y_{ll,LH}$ respectively thus obtaining $I^{(e)}_{2LL}$ and $Q^{(e)}_{2LL}$.

(5) The subbands $Y^{(e)}_{HL}$ and $Y^{(e)}_{LH}$ are obtained as follows:

$(I_{2LL}^{(n)}, Y_{hh,HL}, Y_{hl,HL}, Y_{lh,HL}) \xrightarrow{IDWT} Y^{(e)}_{HL}$

$(Q_{2LL}^{(n)}, Y_{hh,LH}, Y_{hl,LH}, Y_{lh,LH}) \xrightarrow{IDWT} Y^{(e)}_{LH}$

Compression steps

(6) The global bit rate $b_{tot}$ and the bit rate $b_{LL}$, for the subband $Y_{LL}$, are chosen by the user.

(7) The bit rates $b_{HH}, b_{HL}, b_{LH}$ corresponding to the remaining subbands are evaluated according to eqs.(10)-(12).

(8) Finally each subband is compressed using the SPIHT coder and the bit stream $Y_{comp}$ is generated.
Original grayscale image (luminance) → Luminance(Y) with chrominance components (I, Q) embedded

* Notice that perceptually the images pre- and post data hiding are indistinguishable
Original (24bpp)  →  Data Hiding  →  SPIHT  →  JPEG (0.45bpp)