Using PSNR thresholds to modulate the degree of lossy compression in JPEG2000 files

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Disclaimer

I'm not an image scientist, a computer scientist, or a signal processing specialist.
A report from the field

- PSNR encoding JP2 files
- The benefits
- The failings
- Measuring and detecting difference
- Guarding against PSNR failings
- Statistics
JPEG2000 @ the Harvard Library

November 28, 2000, the first JP2 deposited to the Library's Digital Repository Service (DRS).

As of April 11, 2011, 7,925,443 JP2 files totaling 27.2 TB are stored in DRS.
JPEG2000 @ the Harvard Library

TIFF count

File Count

JPEG 2000 Summit, May 2011
JPEG2000 @ the Harvard Library

TIFF data volume

GB

JPEG 2000 Summit, May 2011
JPEG2000 @ the Harvard Library

JP2 data volume

GB

JPEG 2000 Summit, May 2011
Peak Signal to Noise Ratio

The phrase peak signal-to-noise ratio, often abbreviated PSNR, is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmic decibel scale.

Wikipedia entry
Peak Signal to Noise Ratio

The PSNR is most commonly used as a measure of quality of reconstruction in image compression etc. It is most easily defined via the mean squared error (MSE) which for two \( m \times n \) monochrome images \( I \) and \( K \) where one of the images is considered a noisy approximation of the other is defined as:

\[
MSE = \frac{1}{mn} \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} \| I(i, j) - K(i, j) \|_2^2
\]

The PSNR is defined as:

\[
PSNR = 10 \cdot \log_{10} \left( \frac{MAX^2_I}{MSE} \right) = 20 \cdot \log_{10} \left( \frac{MAX_I}{\sqrt{MSE}} \right)
\]
Peak Signal to Noise Ratio

In expressing PSNR as an image encoding parameter, you make explicit the difference you are willing to accept between the source image and the lossy compressed copy you are creating.
Other options?

• Fixed file size

• Fixed compression ratio (encoded file to source file)
Why did we elect to control compression using PSNR?

- PSNR is a smart control.
- It adjusts compression based on the content of the image.
- Image content: The arrangement and distribution of pixel-to-pixel differences within the source image.
- PSNR is a smart control, but it isn't perfect.
IT WORKS
5 least compressed page images
5 most compressed page images
5 least compressed page images
5 most compressed page images
5 most compressed page images
5 least compressed page images
5 most compressed page images
5 least compressed page images
5 most compressed page images

0005.jpg
Today, 6:46:01 PM

0006.jpg
Today, 6:46:02 PM

0009.jpg
Today, 6:46:03 PM

0244.jpg
Today, 6:46:14 PM

0441.jpg
Today, 6:46:05 PM
5 least compressed page images
5 most compressed page images
5 least compressed page images
5 most compressed page images
IT FAILS
"But suppose Thomas Jefferson was to come back here now."
Measuring Difference
"But suppose Thomas Jefferson was to come back here now."
"But suppose Thomas Jefferson was to come back here now."
"But suppose Thomas Jefferson was to come back here now."
“But suppose Thomas Jefferson was to come back here now.”
Wrapped in a shell script

OPTIONS

- pm value  set the minimum PSNR value
- pt        continue on if over maximum ration and PSNR > 50
- rt value  set the maximum allowed filesize ratio
- th size   set the maximum thumbnail size
- ts size   set the tile size
- log       generate a summary file
- h         display this message
Statistics

• Compression starting db: 40
• Compression ratio boundary: 25
• Total compressed files: 274
• Average compression ratio: 14.3430656934307
• Median compression ratio: 13
## Compression ratio / file count

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Tools & Utilities

• Free tools

  • GeoJasper: "GeoJasper is a free and open source geo-supporting extension for JPEG2000 JasPer library and a command line transcoder."

  • JHOVE: an extensible framework for format validation.

  • IrfanView: Freeware image viewing application (Windows) that supports JPEG2000 rendering. You'll need all the plugins.

  • Cygwin: A Unix-like environment for Windows.

• Commercial applications

  • LuraTech: image encoding and server-side decoding software
  • Aware, Inc.: image encoding and server-side decoding software
Thank you

• Mingtao Zhao, *Systems Analyst and Applications Developer*, Harvard College Library

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• Alexis Tzannes, *Senior Engineer*, Advanced Products Group, Aware, Inc.