

# PSNR: a measure of image quality

Prof. Noel E. O'Connor

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When attempting to evaluate lossy image and video compression algorithms some image quality metric is required. This metric should measure the quality of the reconstructed (i.e. decoded) image with respect to the original image. In this way, the output of two different compression algorithms for the same image at a pre-defined bitrate can be meaningfully compared. The metric which is most often used is the Peak Signal to Noise Ratio (PSNR). This was the measure used by the MPEG Video Group when developing the compression tools for standards like MPEG-1, MPEG-2 and MPEG-4<sup>1</sup>.

The PSNR is calculated on the basis of the Mean Square Error (MSE) between the reconstructed image and the original image. If  $I(x, y)$  denotes the original image consisting of  $N \times M$  pixels and  $\hat{I}(x, y)$  denotes the reconstructed image, then the MSE between the two images is calculated as:

$$MSE = \frac{\sum_{x=0, y=0}^{N, M} |I(x, y) - \hat{I}(x, y)|^2}{N \times M}$$

The PSNR (in decibels) assuming 8 bits per pixel can then be calculated as:

$$\begin{aligned} PSNR &= 20 \log_{10} \frac{255}{\sqrt{MSE}} \\ &= 20 \log_{10} \frac{255}{\sqrt{\frac{\sum_{x=0, y=0}^{N, M} |I(x, y) - \hat{I}(x, y)|^2}{N \times M}}} \end{aligned}$$

PSNR values typically lie in the range 20dB - 40dB and are usually rounded to three decimal places. When dealing with video sequences, average PSNR values calculated for the entire sequence are usually quoted, and presented with a plot of PSNR versus frame number.

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<sup>1</sup>It was also used by ISO when developing the JPEG standard and by ITU-T when developing H.261 and H.263.

It should be noted that the PSNR measure does not necessarily correspond to subjective image quality as perceived by the human visual system. As such, the PSNR value in itself is of limited use. Rather, it is the difference between two PSNRs which gives some *indication* of *relative* image quality. In fact, the PSNR as an objective measure should always be complemented by a subjective evaluation based on actually viewing the image. This is the motivation behind the approach to algorithm evaluation used by the MPEG Video Group: in order for a particular compression tool to be included as part of a MPEG standard, it must exhibit an improvement in both PSNR and subjective image quality over its competitors<sup>2</sup>.

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<sup>2</sup>... which leads to many a protracted discussion between MPEG experts (and consequently many late nights!) when developing standards.