

## Chapter 55

# Blind Assessment of Wavelet-Compressed Images Based on Subband Statistics of Natural Scenes

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### ABSTRACT

*This paper presents a no-reference image quality assessment metric that makes use of the wavelet subband statistics to evaluate the levels of distortions of wavelet-compressed images. The work is based on the fact that for distorted images the correlation coefficients of the adjacent scale subbands change proportionally with respect to the distortion of a compressed image. Subband similarity is used in this work to measure the correlations of the adjacent scale subbands of the same wavelet orientations. The higher the image quality is (i.e., less distortion), the greater the cosine similarity coefficient will be. Statistical analysis is applied to analyze the performance of the metric by evaluating the relationship between the human subjective assessment scores and the subband cosine similarities. Experimental results show that the proposed blind method for the quality assessment of wavelet-compressed images has sufficient prediction accuracy (high Pearson Correlation Coefficient, PCCs), sufficient prediction monotonicity (high Spearman Correlation Coefficient SCCs) and sufficient prediction consistency (low outlier ratios) and less running time. It is simple to calculate, has a clear physical meaning, and has a stable performance for the four image databases on which the method was tested.*

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## **INTRODUCTION**

With the rapid development of multimedia technology over the mobile devices on the Internet and broadband communication networks, more image data are in need to be transferred over tighter bandwidth. This drives to the development of more advanced compression technology for image coding. Inevitably, images suffer a variety level of distortions in different compression coding processes (Wallace, 2003; Taubman & Marcellin, 2002). How to evaluate these images and determine which coder is better or more appropriate for an application is vital for both the image providers and users. A straightforward method for doing this is to assess the coded images by human observation alone because they are the final perceivers of the images. Techniques employing this method are called subjective assessment. Subjective assessment is time-consuming, expensive, and controversial. As a result, the development of more accurate and robust objective image quality assessment methods is getting more attention nowadays (Rohaly, Libert, Corriveau & Webster, 2000).

There are three types of objective image assessment methods existing: full-reference (FR), reduced-reference (RR), and no-reference (NR), respectively. In the FR method, a reference or undistorted image is required to present for assessing the corresponding qualities of the distorted images. However, in most image processing applications, it is difficult, if not impossible, to gain an access to the original or undistorted images. RR method requires a partial presence of original image or some extracted features of original image to assess the quality. It is feasible to transmit the extracted RR feature data to the receiver through an ancillary channel of communication for this purpose (Wang, Sheikh & Bovik, 2003). However, in many practical applications, the reference image is not available and the use of an ancillary channel could also be too expensive. Thus, the NR quality assessment approaches are more desired in most situations.

In the last three decades, a great deal of effort has been made to develop objective image and video quality assessment methods, especially on FR metrics. The most commonly used FR objective image and video distortion (or quality) metrics are mean squared error (MSE) and peak signal-to-noise ratio (PSNR). MSE and PSNR are widely used because they are simple to calculate, have clear physical meanings, and are mathematically easy to deal with for optimization purpose. However, the metrics have been widely criticized as well for not correlating well with human perceived quality measurement (Wang, Bovik, Sheikh, & Simoncelli, 2004), though the phase I test of the video quality experts group (VQEG) (Rohaly, Libert, Corriveau & Webster, 2000) achieved some success. Therefore the VQEG is continuing the work on Phase II for testing RR and NR assessment methods on television and Internet multimedia signals.

Most existing NR image quality metrics are developed for measuring image blocking (Karunasekera & Kingsbury, 1995; Brandão & Queluz, 2008; Wang, Sheikh & Bovik, 2002), and hence are only suitable for JPEG image compression. In JPEG2000, an image is decomposed and reconstructed using wavelets and coded according to self-similarities among wavelet subbands (Shapiro, 1993; Said & Pearlman, 1993), or wavelet blocks within a subband (Taubman, 2000). The method has higher coding performance than DCT-based image codec, but has different distortions with blocking, for example, the blurring and ringing. There exist three major types of NR assessment algorithms currently for JPEG2000 compressed images: edge information (Parvez Sazzad, Kawayoke & Horita, 2008; Zhang & Le, 2010), HSV (Barland & Saadane, 2006; Chetouani, Mostafaoui & Beghdadi, 2009), and natural scene statistics (NSS) (Sheikh, Bovik & Cormack, 2005; Tong, Li, Zhang & Zhang, 2004; Zhou, Xiao & Li, 2008; Moorthy & Bovik, 2010; Buccirossi & Simoncelli, 1999).

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