Image Blur Estimation
Based on the Average Cone of Ratio in the Wavelet Domain

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Abstract. Recently, we proposed a new algorithm for objective blur estimation using wavelet decomposition. In particular, the method makes use of a wavelet domain local regularity measure named average cone ratio (ACR). The ACR quantifies joint expansion of the magnitudes of wavelet coefficients inside a cone of influence which is centered at the given spatial position and it was shown to be a good estimate of the local Lipschitz exponent. Moreover, it has been shown that the ACR measure is highly robust to noise.

In our work, these advantageous properties of ACR: estimating local edge regularity while being insensitive to noise, are used for blur estimation. Namely, our proposed method is designed to estimate blur as a function of the center of gravity of the ACR histogram. The new metric is named CogACR. The method of CogACR is applicable both in case where the reference image is available and when there is no reference.

Our results demonstrate a consistent performance of the proposed metric for a wide class of natural images and in a wide range of both Gaussian and out of focus blurriness, and over a wide range of noise. One of important conclusions of our study is that the *CogACR* may be used as a powerful metric of image blur over a wide range of blur levels and while being nearly insensitive to noise. Moreover, the results of the study prove the ability of the new blur metric to clearly discriminate between low level quanta of blur in both reference- and no-reference case which encourages further research of the subject. Compared to the existing state-of-the-art methods for blur estimation, the CogACR metric demonstrates not only the significantly greater robustness to noise but also the ability to discriminate between different levels of blur in the image for a noticeably wider range of blurriness. Most recently, we have investigated the feasibility of using CogACR as a real-time metric in HD video quality assessment. Encouragingly, those results suggest that, despite its computational complexity, the metric can be efficiently implemented on a commercially available processor and achieve real-time performance for HD inputs.

Nevertheless, some important aspects of CogACR metric remain to be addressed in order for the method to become a practically working one. Some of these aspects include content sensitivity and this is exactly the focus of our current research interest and a topic of our ongoing investigatios.