Comparative Analysis of Blind Methods for Additive Noise Variance Evaluation in Images

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Abstract - **The comparative analysis for three blind methods for additive noise variance evaluation in images is carried out. Cases of spatially uncorrelated and correlated noise are considered.**

Keywords - **Variance evaluation, Blind methods.**

I. Introduction

For many image and video processing applications, the information on additive noise variance is required. However, such information is a priori unknown in many practical situations. Hence, it is necessary to receive it from images to be processed. Thus, there exists an obvious need in blind methods able to evaluate variance quickly and with appropriate accuracy. Nowadays, there is a lot of such methods designed, but it is difficult to adequately compare their accuracy due to the fact that the results given in literature are often obtained for different images. In addition, commonly only the case of spatially uncorrelated noise is considered, whereas in practice noise can be also spatially correlated. A priori information about noise correlation level is usually absent. To partly fill this gap, we have decided to test some methods for blind evaluation of noise variance using image database TID2008 [1] and considered both the cases of spatially uncorrelated and correlated noise.

II. Comparison Results

For comparison, we have chosen three recently proposed methods. The first method described in [2] operates in spatial domain and is based on the mode determination of local variance estimates distribution. The local variance estimates are obtained using robust PD-estimator. Other two methods operate in spectral domain. In the method [3], the final variance estimate is obtained as the argument of minimum of 2-D function of kurtosis and variance estimates calculated for each spatial frequency in DCT domain. Finally, in method [4] (we mean its version adapted for image processing), a final variance estimate corresponds to the most frequent spatial gradient in wavelet domain.

To compare the aforementioned methods, we have used color images from TID2008 database distorted by additive spatially uncorrelated and correlated noise with variance $\sigma_a^2 = 130$. As the quantitative criterion, bias $\Delta = \hat{\sigma}_a^2 - \sigma_{true}^2$ has been used. The dependences of bias on image index in TID2008 database (the results for green component are presented) for spatially uncorrelated and correlated noise are shown in Figs. 1,a and 1,b. Lines with round, square and triangular markers correspond to the methods [2], [3] and [4], respectively.

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As it is seen, for spatially uncorrelated noise, the method [4] provides significantly underestimated values, the results for the method [3] are rather unstable and it also tends to noticeable

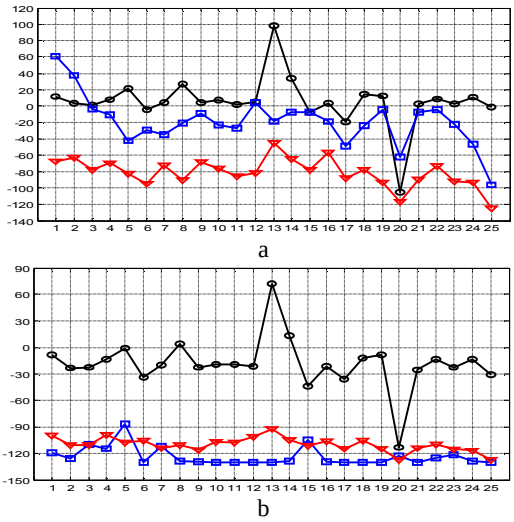

Fig.1 Biases for uncorrelated (a) and correlated noise (b)

underestimation of variance. The method [2] provides the least biased estimates for most images except highly textural images # 13,14 and the image # 20 where clipping effect is present. In the case of spatially correlated noise, the methods [3] and [4] fail completely (provide extremely large underestimation) whereas the method [2] still provides appropriate estimation accuracy in most cases (the results are almost the same as for the case of uncorrelated noise).

III. Conclusion

The method [2] appears to be the most universal and accurate among the considered methods, but it is necessary to improve its accuracy for highly textural images and images where clipping effects are present.

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