Implicit Volterra and Wiener series for higher-order image analysis

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Abstract. The computation of classical higher-order statistics such as higher-order moments or spectra is difficult for images due to the huge number of terms to be estimated and interpreted. We propose an alternative approach in which multiplicative pixel interactions are described by a series of Wiener functionals. Since the functionals are estimated implicitly via polynomial kernels, the combinatorial explosion associated with the classical higher-order statistics is avoided. In addition, the kernel framework allows for estimating infinite series expansions and for the regularized estimation of the Wiener series. First results show that image structures such as lines or corners can be predicted correctly, and that pixel interactions up to the order of five play an important role in natural images.

Paper Category: research paper.
Purpose: Computation of Volterra and Wiener models for images.
Design/Methodology/Approach/Algorithm: Polynomial kernel regression.
Results: Volterra/Wiener models of images can be computed for the first time.
Research Limitations/Implications: The current estimation technique suffers from the unfavorable properties of polynomials and cannot cope with very large datasets. Possible improvements are currently investigated.
Originality/Value: Part of the content has been published elsewhere (see below). We report on newer developments in the estimation techniques and the interpretation of the results. Should be of interest in the context of image and texture modeling, higher-order statistics and natural image statistics.
Key words: Wiener and Volterra series, image modeling, higher-order statistics, kernel methods.

References

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