

ADAPTATIVE DENOISING OF BIOLOGICAL FLUORESCENCE MICROGRAPHS USING DETECTOR PRECISION CHARACTERISTICS.

Tytus Bernas

Royal College of Surgeons in Ireland (RCSI), National Biophotonics And Imaging
Platform Ireland (NBIPI), 123 St Stephens Green, Dublin, Ireland

Introduction: Removal of noise in microscope image processing is usually executed using methods developed for other applications like digital photography or remote sensing. Several such schemes have been developed using wavelet shrinkage (thresholding) for signal-independent (Gaussian) noise and signal-dependent (Poisson) noise. Nonetheless, the problem removal of composite noise (having both signal-dependent and signal-independent components and typical for biological light micrographs) have not been thoroughly addressed.

Methods: Previously developed algorithm [Bernas et al. 2007] is used to calculate the levels of dark and photonic noise corresponding to a fluorescence signal in biological micrographs. These data is correlated quantitatively with the registration parameters adjusted by a microscope operator: gain, acquisition time and detector offset. Micrographs (with known amounts of the two noise types) are used to establish correspondence between local wavelet energy and estimate of total noise at every image pixel. Function of dependence between the noise and energy of pixels of an image registered at a given detector settings is constructed. This information is then embedded into data-adaptative wavelet thresholding algorithm [Sendur 2002].

Results: The proposed algorithm is tested using a set of fluorescence micrographs containing varied levels of signal-dependent and signal-independent noise and representing several types of subcellular structures (nuclei, mitochondria, cytoskeleton etc.). The noise is added to high-quality images which serve as reference to evaluate denoising performance of the algorithm using MSE. This measure was used to compare performance of the proposed technique to two other wavelet thresholding techniques, which adapt to local image content [Chang 2000, Sendur 2002] and to optimal global wavelet thresholding.

Conclusions: The proposed wavelet thresholding technique outperforms other methods when used with biological fluorescence micrographs containing noise of composite characteristics. Application of this algorithm requires only characteristics of microscope detector and information on its settings (i.e. imaging conditions)

Bernas T, Asem E.K., Robinson J.P. & Rajwa B. (2007) Estimation of imaging precision for microscope calibration and image compression. *Journal of Microscopy*, 226(2), 163-174

Sendur, L. & Selesnick, I. W. (2002) Bivariate image shrinkage with local variance estimation. *IEEE Trans. Sig. Proc.*, **50**, 2744-2756.

Chang, S.G, Yu, B, Vetterli, M (2000) Spatially Adaptive Wavelet Thresholding with Context Modeling for Image Denoising *IEEE Trans. Img. Proc.*, **9**, 1522-1531.