EDGE DETECTION IN BIOMEDICAL IMAGES

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Image edges convey undoubtedly the most important part of the percepted information about the objects depicted in an image. Edge detection and sharpening contribute extensively to visual enhancement and objects boundaries detection. The term *edge* denotes an abrupt change in the values of image intensity represented by high frequencies in the Fourier domain. Sharp edges of a step-function profile may by easily detected by short gradient approximating masks. However, these short-tap filters proof insufficient for blurred or noisy edges. Extension of the filter tap length leads to blurring the originally sharp edges. It is more convenient to detect edges of different spatial sizes by multi-scale methods, such as the Canny detector having the form of the first derivative of Gaussian with variable standard deviation.

In this paper, all the above techniques are applied to biomedical CT and MR images of the brain. Prior to edge extraction, we carry out noise reduction by wavelet coefficients shrinkage. For this purpose, we use either the Discrete Wavelet Transform (DWT) or the Dual-Tree Complex Wavelet Transform (DTCWT) designed by N. Kingsbury. The latter outperforms the DWT by its approximate shift invariance and better directional selectivity in higher dimensions.

Furthermore, owing to their sparsity and persistence, the DTCWT coefficients may be modeled by Hidden Markov models (HMM) and utilized for edge detection. The *sparsity* property is entailed by a large number of small coefficients from smooth regions and fewer large coefficients corresponding to singularities. Hence the marginal distribution of coefficients magnitudes of each scale is modeled as a 2-component mixture of Rayleigh distributions of a small variance $\sigma_{n,S}$ and a large variance $\sigma_{n,L}$. Markovian dependencies tie together the hidden states (S or L) not the coefficients values. The *persistence* property denotes propagation of the relative size of the coefficients through scale. In this sence, the DTCWT is more suitable than the DWT for its approximate shift invariance of magnitudes which do not oscillate across scale at the location of a singularity.

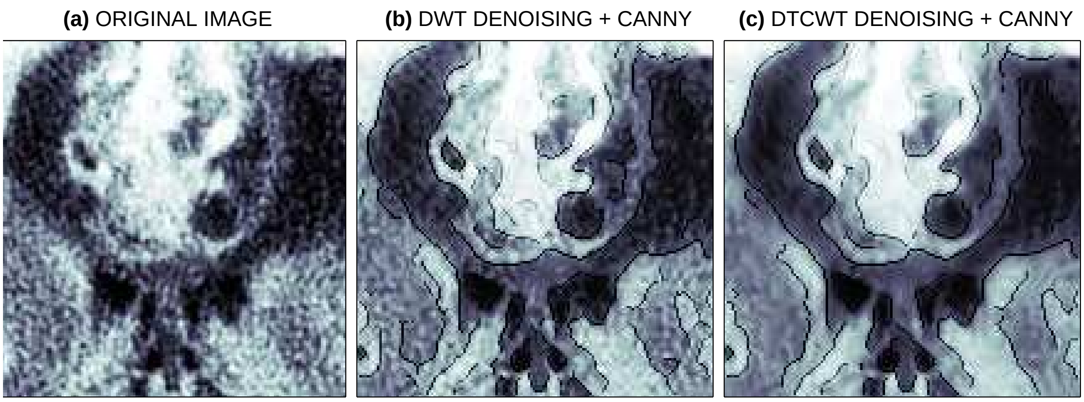

Figure 1 – Canny edge detector applied to a CT brain image presenting **(a)** the original image of a large malignant tumor gliom IV (tumor - white, necrosis - dark spots inside the tumor, edema around the tumor - dark), **(b)** and **(c)** images processed using the Canny detector (scale $\sigma = 1.8$) after de-noising by wavelet shrinkage exploiting the DWT and the DTCWT, resp.