A PSEUDO-LOGARITHMIC IMAGE PROCESSING FRAMEWORK FOR EDGE DETECTION

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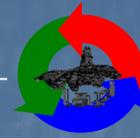
Abstract. The paper presents a new [pseudo-] Logarithmic Model for Image Processing (LIP), which allows the computation of gray-level addition, substraction and multiplication with scalars within a fixed gray-level range [0;D] without the use of clipping. The implementation of Laplacian edge detection techniques under the proposed model yields superior performance in biomedical applications as compared with the classical operations (performed either as real axis operations, either as classical LIP models).

Logarithmic image processing (LIP) approaches: homomorphism which transforms the product into a sum (by logarithm)

Classical LIP

$$v_1 \oplus v_2 = v_1 + v_2 - \frac{v_1 v_2}{D}$$

$$\lambda \otimes v = D - D\left(1 - \frac{v}{D}\right)^{\lambda}$$

Homomorphic LIP

$$z_1 \oplus z_2 = \frac{z_1 + z_2}{1 + z_1 z_2}$$

$$\lambda \otimes z = \frac{(1+z)^{\lambda} - (1-z)^{\lambda}}{(1+z)^{\lambda} + (1+z)^{\lambda}}$$

Pseudo - LIP

$$v_1 \oplus v_2 = \frac{v_1 + v_2 - 2v_1 v_2}{1 + v_1 v_2}$$

$$\lambda \otimes v = \frac{(1+v)^{\lambda} - (1-v)^{\lambda}}{(1+v)^{\lambda} + (1+v)^{\lambda}}$$

Laplacian operator

$$\Delta(i,j) = \sum_{(k,l) \in V_4} (f(i+k, j+l) - f(i,j))/4$$
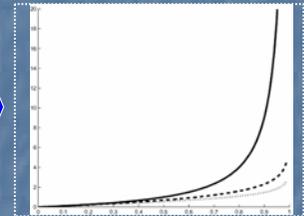
Results

Gray-level image
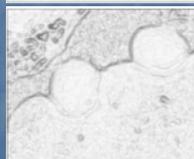
Original Classic Laplacian Homomorph LIP LIP type Laplacian

Color image
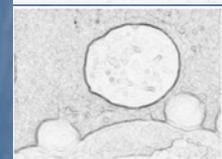
Original Classic Laplacian Homomorph LIP LIP type Laplacian

Conclusions We presented a new [pseudo-] Logarithmic Model for Image Processing (LIP), which allows the computation of gray-level addition, substraction and multiplication with scalars within a fixed gray-level range [0;D] without the use of clipping. The implementation of classical edge detection techniques under the proposed model yields significant superior performance as compared with the classical operations (performed either as real axis operations, either as classical LIP models). The tests performed on various images from biomedical applications show the good performance of the proposed approach.