Parameterization Method for Logarithmic Image Processing Model

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Abstract - **In this paper a new parameterization method for logarithmic image processing (LIP) model is presented. This method is based on nonlinear transformation with using bijection. The use of this method provide means for construction of different logarithmic type algebras for image processing.**

Keywords – **logarithmic image processing, image enhancement, parameterization of image processing**

I. Introduction

Image enhancement is an important part of the pre-processing in computer vision and image analysis systems. Very often images have low contrast, are too bright or too dark. In such cases processing with LIP model is one of the possible approaches. However the known approaches don't provide possibility for effective processing adaptation since they don't contain any parameter for quality control of this procedure. The known approach described in paper [1], however it's efficiency is low. Therefore the aim of this work is to construct a method for parameterization of LIP models. First, we describe some known LIP models. Then, we derive new approach to parameterization.

II. LIP models

LIP model is presented in paper [1], where the following expressions for arithmetic operations are used:

$$\forall (u,v) \in (0, M) \qquad u \oplus v = u + v - \frac{u \cdot v}{M} \tag{1}$$

$$\forall \alpha > 0 \qquad \alpha \otimes u = M - M\left(1 - \frac{u}{M}\right)^{\alpha} \tag{2}$$

This model is generalized in [2, 3]:

$\forall (x, y) \in (-M, M)$, where $M > 0$,

$$u\langle + \rangle v = \operatorname{sign}(u+v) \cdot M \times \left(1 - \left((1 - \frac{|u|}{M})^{\operatorname{sign}(u)} \cdot (1 - \frac{|v|}{M})^{\operatorname{sign}(v)}\right)^{\operatorname{sign}(u+v)}\right), \tag{3}$$

$\forall \alpha \in R, \forall u \in (-M, M)$

$$\alpha \langle \times \rangle u = \operatorname{sign}(\alpha \cdot u) \cdot M \cdot \left(1 - (1 - \frac{|u|}{M})^{|\alpha|}\right). \tag{4}$$

II. Parameterized LIP models

Parametrical representation of LIP model (3)-(4) is presented in [3, 4]: $\forall (x, y) \in (-M, M)$, where $M > 0$,

$$u\langle + \rangle v = \operatorname{sign}(u+v) \times M \times \left(1 - \left((1 - \frac{|u|^p}{M})^{\operatorname{sign}(u)} \times (1 - \frac{|v|^p}{M})^{\operatorname{sign}(v)}\right)^{\operatorname{sign}(u+v)}\right)^{1/p} \tag{5}$$

$\forall \alpha \in R, \forall u \in (-M, M)$

$$\alpha \langle \times \rangle u = \operatorname{sign}(\alpha \cdot u) \cdot M \cdot \left(1 - (1 - \frac{|u|^p}{M})^{|\alpha|}\right)^{1/p} \tag{6}$$

The analysis of (3), (5) and (4), (6) allows to conclude: if a strictly monotonic function (bijection) $\psi : [0,1] \to [0,1]$, ($\psi(0) = 0$, and ψ^{-1} is an inverse function of ψ), then a general approach to construction of expressions for arithmetic operations in the transformed algebraic model is

$\forall (x, y) \in (-M, M)$,

$$\psi(u\langle + \rangle v) = \operatorname{sign}(u+v) \cdot M \cdot \times \psi^{-1}\left(1 - \left((1 - \psi\left(\frac{|u|}{M}\right))^{\operatorname{sign}(u)} \cdot (1 - \psi\left(\frac{|v|}{M}\right))^{\operatorname{sign}(v)}\right)^{\operatorname{sign}(u+v)}\right) \tag{7}$$

$\forall \alpha \in R, \forall u \in (-M, M)$

$$\psi(\alpha \langle \times \rangle u) = \operatorname{sign}(\alpha \cdot u) \cdot M \cdot \psi^{-1}\left(1 - (1 - \psi(\frac{|u|}{M}))^{|\alpha|}\right) \tag{8}$$

When y is defined as a parametric function $\psi = F(x, p)$ we obtain parametric algebraic LIP model.

III. Conclusion

Experimental results confirm an efficiency of the propose approach for construction of parametric LIP models for image enhancement.

References

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