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A multiscale mathematical morphology to enhance contrast, preserve brightness, and improve detail in the image

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1 Introduction

Contrast is defined as the difference in luminance between an object and its surroundings. The higher the contrast, the better the differentiation between the background and the object. Contrast enhancement allows images to be more suited to human visual perception. Contrast enhancement is important for its applications in different areas of science, such as medicine, engineering and geoscience [2]. Specifically, the multiscale top-hat transform has been shown efficient in improving different types of images, such as: medical images, visible images, infrared images, among others [1]. In this work, a new contrast enhancement algorithm based on the multiscale top-hat reconstruction transformation is presented.

2 Proposed Algorithm

The algorithm is inspired by the proposal of Bai et al. [1]. The proposal differs from the previous one in: 1) No contrast adjustment weight is used and 2) the maximum between all scales is calculated. The proposal was compared with the Histogram Equalization

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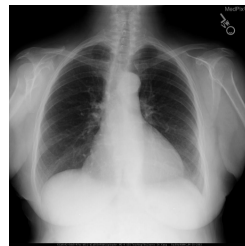
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(HE) and the proposal of Bai et al. [1] (MMLCE). The HE, MMLCE and the proposal were validated with: Standard Deviation (SD), Peak Signal-to-Noise Ratio (PSNR) and Absolute Mean Brightness Error (AMBE). The parameters for the MMLCE and the proposal are $n=5$ (number of iterations) and the initial structuring element of disk shape of $r = 1$, where r increases in each iteration in steps of one. For the tests 20 images were selected from different public databases ⁶⁷. Table 1 shows the average results of the 20 images obtained by the HE, MMLCE and the proposal. Where the proposal distorted less the original image according to PSNR, better preserved the average brightness according to AMBE and also improved the contrast of the original image according to SD.

Table 1: Average results of the 20 images obtained by the HE, MMCE and the proposal.

Algorithms	SD	PSNR	AMBE
I	48.141	-	-
HE	71.987	14.168	40.058
MMLCE	50.200	29.999	0.569
Proposal	49.537	33.624	0.445

In Figure 1 we can see that the proposal improves the contrast and details of the image and preserves the average brightness.



(a) Original Image



(b) Image enhanced with proposed method

Figure 1: Visual results of experiment

References

- [1] X. Bai. Image enhancement through contrast enlargement using the image regions extracted by multiscale top-hat by reconstruction. *Optik-International Journal for Light and Electron Optics*, 124(20):4421–4424, 2013.
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⁶<https://openi.nlm.nih.gov/>

⁷<https://projects.asl.ethz.ch/datasets/doku.php?id=ir:iricra2014>