

ADAPTIVE LOCAL IMAGE ENHANCEMENT BASED ON LOGARITHMIC MAPPINGS

Jose-Luis Lisani

joseluis.lisani@uib.es



Universitat
de les Illes Balears



Unión Europea



ABSTRACT

A new local image enhancement technique is proposed. It is based on a logarithmic mapping function that is adapted to the luminance characteristics of the neighborhood of each pixel. The method permits to simultaneously increase the luminance in dark regions and decrease it in bright regions. The result is an image with an overall improved contrast.

INTRODUCTION

Global image enhancement techniques are unable to deal simultaneously with dark and bright regions of the image, since an increase in contrast in the dark regions leads to a decrease in contrast in the bright regions and vice versa.

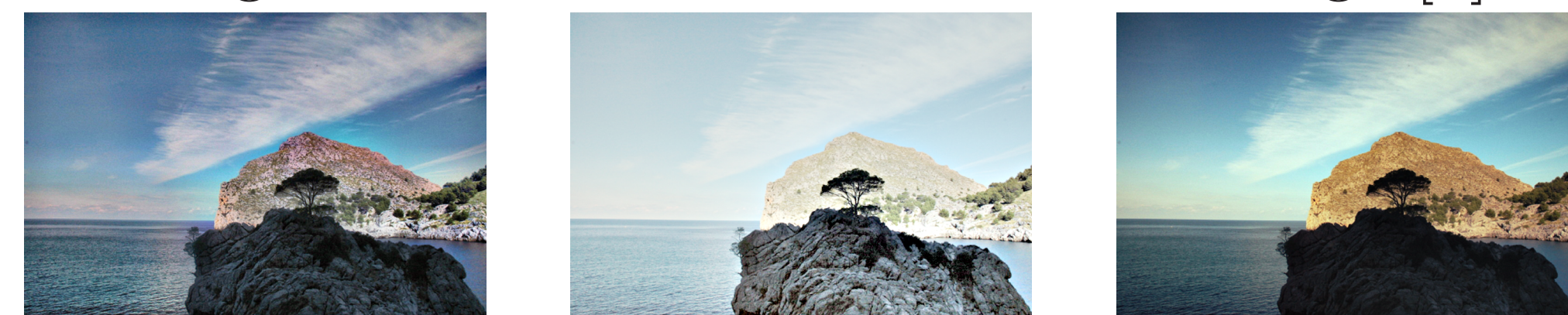
Local techniques adapt the enhancement in the spatial neighborhood of each pixel and obtain better results. However, most of these techniques successfully enhance the contrast of poorly illuminated regions of the image but do not significantly improve (or even reduce) the contrast in bright regions.



Original

HE

Drago [1]

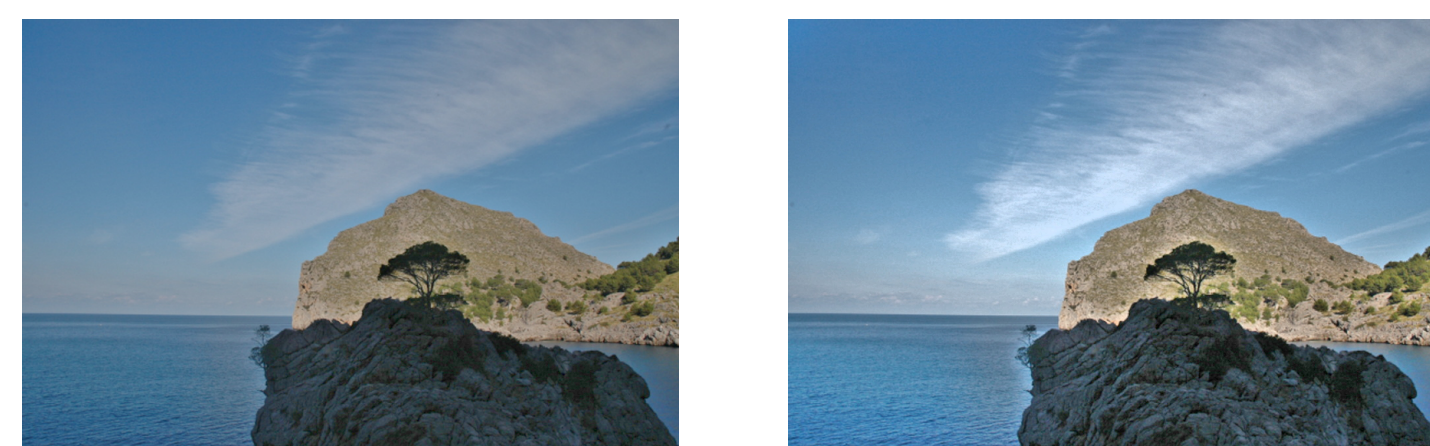


CLAHE

MSR [2]

ACE [3]

We propose a new method that is able to improve the visibility in both dark and bright regions. The method follows an approach similar to Local Color Correction (LCC) [4] but produces a further enhancement of the image contrast.



LCC

Proposed

ACKNOWLEDGEMENTS

Research supported by grants TIN2014-53772, TIN2017-85572-P, TIN2014-58662-R and DPI2017-86372-C3-3-R. (MINECO/AEI/FEDER, UE).

DESCRIPTION OF THE METHOD

1) Use of a family of logarithmic mapping

$$L_{\alpha}(I) = \begin{cases} 255 \frac{\log(\alpha I + 1)}{\log(255\alpha + 1)}, & \text{if } \alpha > 0 \\ I, & \text{if } \alpha = 0 \\ 255(1 - \frac{\log(|\alpha|(255 - I) + 1)}{\log(255|\alpha| + 1)}), & \text{if } \alpha < 0 \end{cases}$$

(Steepest increase for small values than gamma correction mappings)

2) Estimation of local luminosity: anisotropic smoothing of intensity channel (Mean Curvature Motion PDE [5])

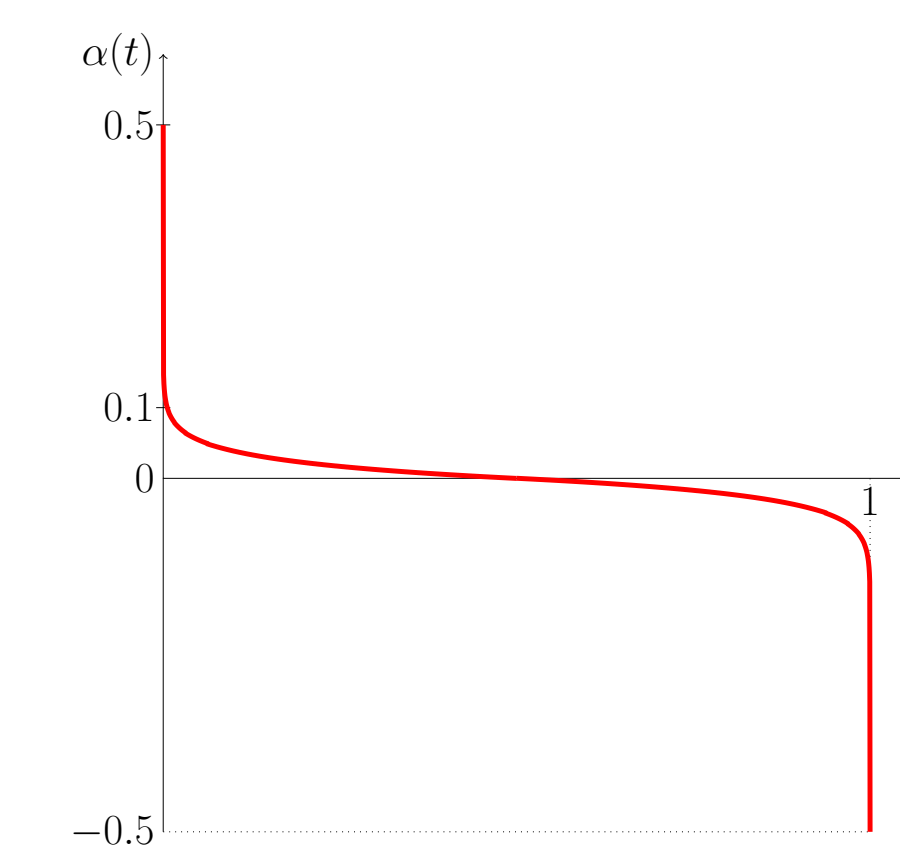
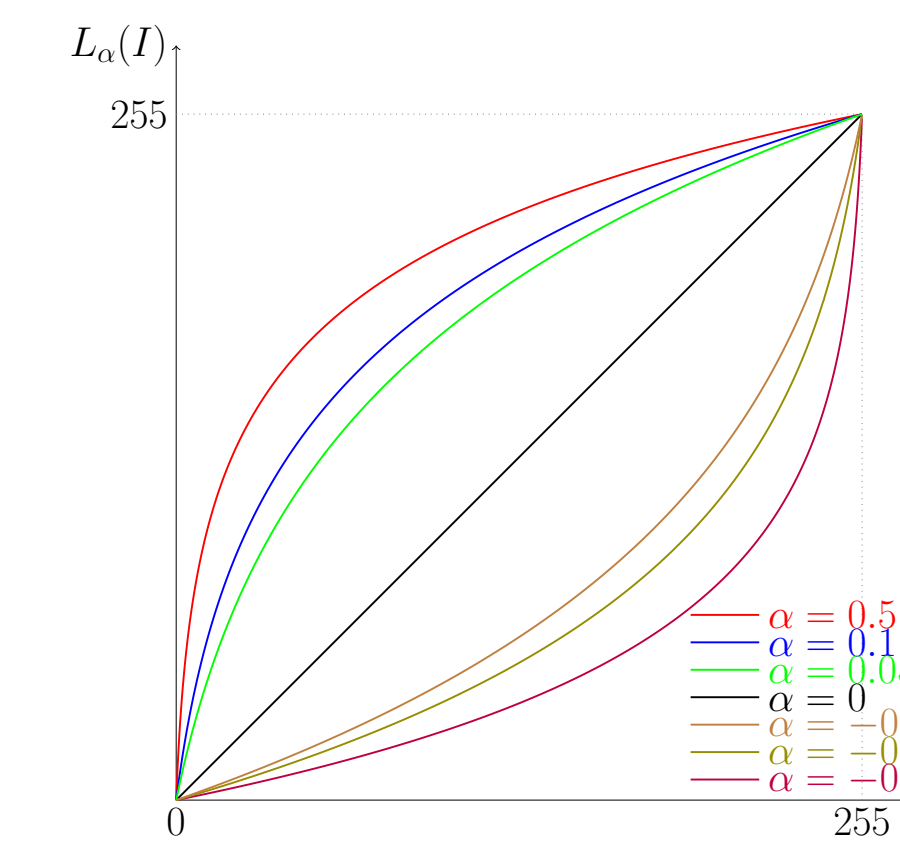
$$M(I) = \text{MCM}_{\sigma}(I/255)$$

(Better preservation of image countours w.r.t. Gaussian smoothing)

3) Apply a different mapping to each pixel: brighten dark areas, darken bright areas.

$$I_{\text{new}} = L_{\alpha(M(I))}(I)$$

$$\alpha(t) = \begin{cases} 0.5(1 - (\frac{t}{0.5})^{0.05}), & \text{if } t \leq 0.5 \\ -0.5(1 - (\frac{1-t}{0.5})^{0.05}), & \text{if } t > 0.5 \end{cases}$$



EXPERIMENTAL RESULTS



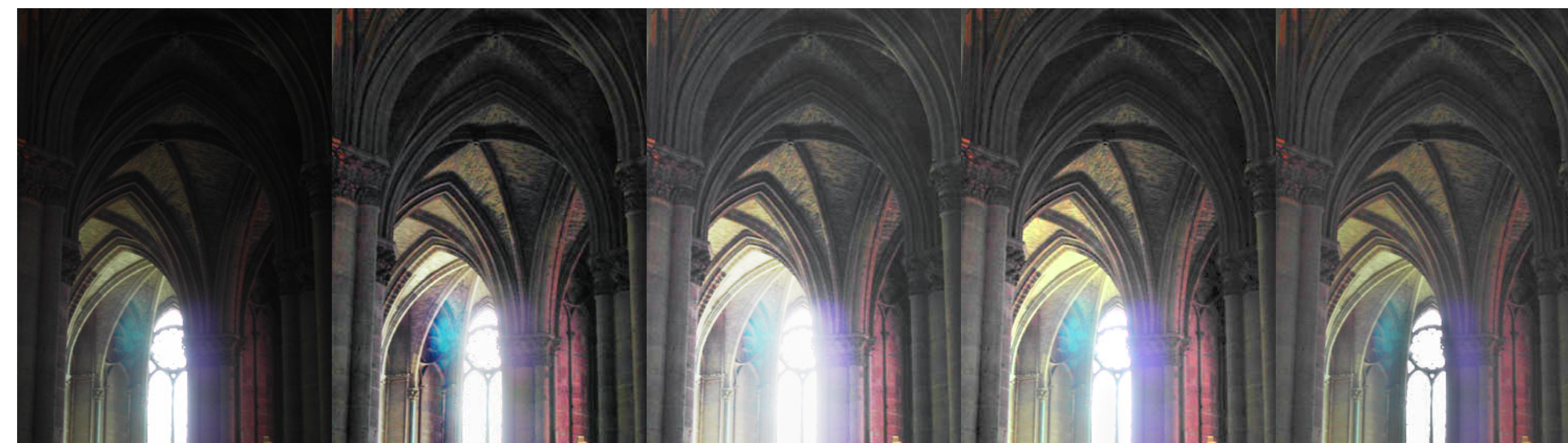
Original

CLAHE

MSR

LCC

Proposed



Original

CLAHE

ACE

MSR

Proposed

QUANTITATIVE RESULTS

Original	CLAHE	ACE	LCC	MSR	Proposed
3.46	3.05	3.15	3.13	3.13	3.06

Average NIQE [6] values over 50 images.

Original	CLAHE	ACE	LCC	MSR	Proposed
7.10	7.61	7.59	7.17	7.42	7.23

Average entropy values over 50 images.

CONCLUSIONS

We have proposed a new image enhancement technique based on a set of logarithmic tone mappings which are locally applied to each image pixel depending on the luminance characteristics of its neighborhood. This permits an enhancement of the luminance in dark and bright image regions, as opposed to most methods in the literature which are unable to deal simultaneously with both kinds of regions. The result is an image with an overall improved contrast. Qualitative and quantitative evaluation of the obtained results attest to the validity of the proposed method.

Online demo:

<http://ipolcore.ipol.im/demo/clientApp/demo.html?id=77777000035>

REFERENCES

- [1] F. Drago, K. Myszkowski, T. Annen, and N. Chiba, "Adaptive logarithmic mapping for displaying high contrast scenes," in *Proceedings of EUROGRAPHICS*, 2003, vol. 22.
- [2] D. J. Jobson, Z. Rahman, and G. A. Woodell, "A multiscale retinex for bridging the gap between color images and the human observation of scenes," *IEEE Transactions on Image Processing*, vol. 6, no. 7, pp. 965–976, 1997.
- [3] A. Rizzi, C. Gatta, and D. Marini, "A new algorithm for unsupervised global and local color correction," *Pattern Recognition Letters*, vol. 24, no. 11, pp. 1663–1677, 2003.
- [4] N. Moroney, "Local color correction using non-linear masking," in *IS&T/SID Eight Color Imaging Conference*, 2000, pp. 108–111.
- [5] Luis. Alvarez, F. Guichard, P-L. Lions, and J-M. Morel, "Axioms and fundamental equations of image processing," *Archive for Rational Mechanics and Analysis*, vol. 123, no. 3, pp. 199–257, Sep 1993.
- [6] A. Mittal, R. Soundararajan, and A. C. Bovik, "Making a completely blind image quality analyzer," *IEEE Signal Processing Letters*, vol. 20, no. 3, 2013.