

# A Novel Approach to Image Enhancement Using a $2 \times 2$ Model for Color-to Grayscale Mapping

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## INTRODUCTION

A novel technique is presented with the aim to improve the visual quality of digital images by transforming a color mage to a double sized grayscale image and then processing the image with a variety of different image processing techniques such as Histogram Equalization, Alpha Rooting, Multi-Retinex, with finally mapping the results back to colors.

**The Color image is first upscaled by a  $2 \times 2$  model and then being processed as a single grayscale image.**

**The gray-component:  $I = 0.3R + 0.59G + 0.11B$**

I(0,0)	B(0,0)	I(0,1)	B(0,1)	I(0,2)	B(0,2)	...
R(0,0)	G(0,0)	R(0,1)	G(0,1)	R(0,2)	G(0,2)	...
I(1,0)	B(1,0)	I(1,1)	B(1,1)	I(1,2)	B(1,2)	...
R(1,0)	G(1,0)	R(1,1)	G(1,1)	R(1,2)	G(1,2)	...
...	...	...	...	...	...	...

Table 1.  $2 \times 2$ -model of color-gray transformed image.



Figure 1. Original image.



Figure 2.  $2 \times 2$  upscaled image with grayscale for color channels.



Figure 3. Color image enhancement after 0.81-rooting in the  $2 \times 2$  model.

## METHODS



Figure 4.  $2 \times 2$  upscaled image with Histogram Equalization.



Figure 5.  $2 \times 2$  upscaled image with Histogram Equalization and Gradient Buffer.

Figure 6. Figure 4 returned to RGB after the histogram equalization (HE) in the  $2 \times 2$  model.



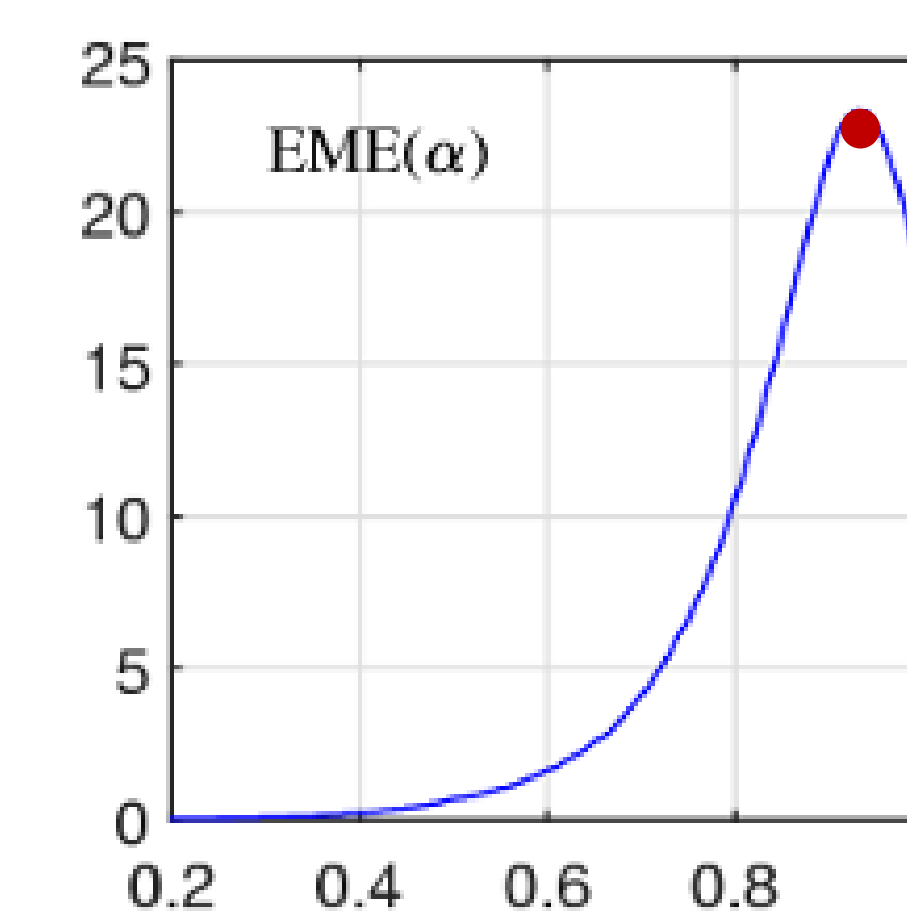
Figure 7. Original color image processed with the multi-retinex



Figure 8. Image processed from  $2 \times 2$  model with gradient-based histogram equalization on grays [1].



## RESULTS



Graph. 1 EMEC of the image in  $2 \times 2$  model



Fig. 9 Original Image



Fig. 10 After Histogram Equalization



Fig. 11 Multi-Retinex Algorithm



Fig. 12 After Alpha Rooting ( $\alpha = 0.93$ )

$$EMEC(f) = \frac{1}{k_1 k_2} \sum_{k=1}^{k_1} \sum_{l=1}^{k_2} 20 \ln \frac{\max(r, g, b)_{k,l}}{\min(r, g, b)_{k,l}}$$

(The image is divided by blocks  $5 \times 5$ ,  $5 \times 7$ , ... [2])

Image	EMEC
Original	29.18
HE	37.57
M-Retinex	21.92
Alpha Root	24.55

**Image Quality Retention After Applying the  $2 \times 2$  Model compared with Retinex, Alpha-rooting [3], and HE.**

## CONCLUSIONS

1. Our preliminary experimental results on color images show effectiveness of the proposed  $2 \times 2$ -model.
2. This model can be used with any 2-D image (in other color models, CMYK, XYZ, ...) to improve image quality retention after the processing.

**This  $2 \times 2$  model is a novel approach in color imaging that ensures quality retention in the color image compared to not using it before image processing.**

## REFERENCES

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