Natural Rendering of Color Image Baesd on Retinex

IEEE International Conference on Image Processing(ICIP), 2009

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Abstract

- Proposed method
  - New method of natural rendering of color image
    - Based on Retinex
    - Not changing ambience of image after enhancement
      - Not introducing additional light sources
      - Not produce halo effect or amplify blocking effect
    - Use of Retinex theory and histogram rescaling techniques

Introduction

- Retinex theory
  - One of the most appealing approaches
    - Image enhancement
    - Color constancy
  - Many Retinex algorithms
    - Path version
    - Iterative version
    - Center/surround version
  - Not be directly applied into image enhancement

– Example of Retinex algorithm

Fig. 1. Left: Original image; Middle: Image enhanced by NASA Retinex; Right: Image enhanced by NRCIR(the proposed method).

Fig. 2. Left: Original image; Middle: Image enhanced by RGB 3-channel Retinex; Right: Image enhanced by NRCIR.

– Example of image enhancement algorithm

Fig. 3. Left: Original image; Middle: Image enhanced by algorithm of [8]; Right: Image enhanced by NRCIR.

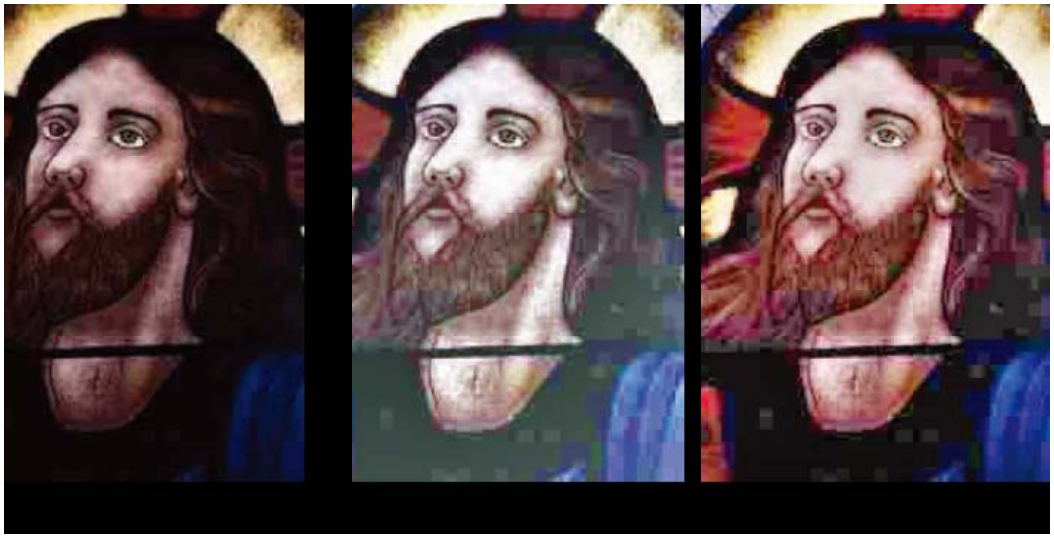

Fig. 4. Left: Original image; Middle: Image enhanced by RGB 3-channel Retinex; Right: Image enhanced by NRCIR.

Flowchart of NRCIR

- Proposed method
  - Dividing five steps
    - Global mapping operation
      - Serving as a pre-treatment of image rendering
    - Inspiring one-filter Retinex
    - Applying a histogram rescaling to luminance channel for white point correction
    - Creating reference map
      - Use of weight RGB channels
    - Another histogram rescaling

– Flowchart of NRCIR

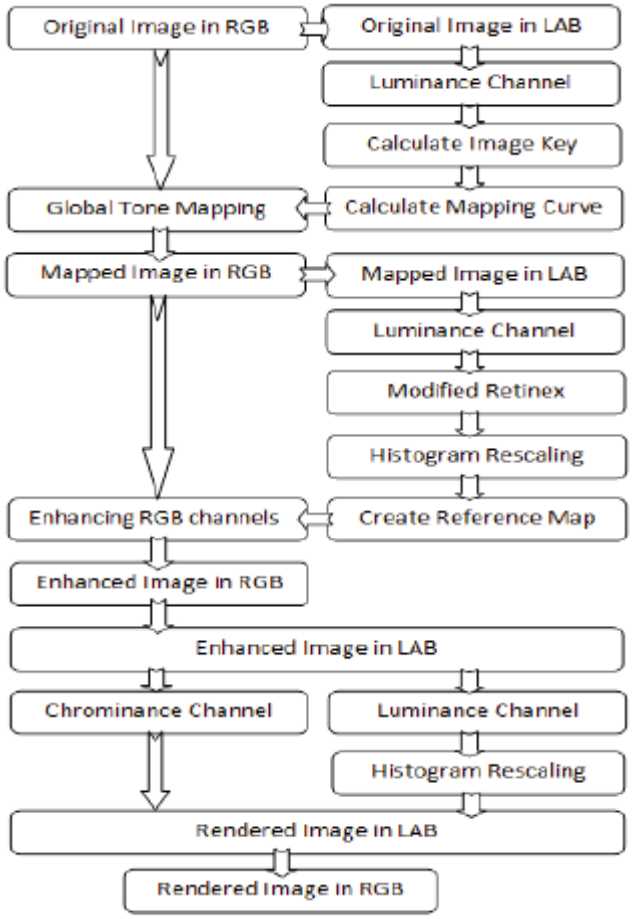

Fig. 5. Flowchart of NRCIR

NRCIR details and test results

- Global mapping function
  - Avoiding over enhancement of blocking effect
    - Use of circle function
    - Producing moderate gain

$$key = e^{\frac{\sum_x \sum_y \log(L(x,y))}{size(I)}} \tag{1}$$

$$r = \begin{cases} 3 \times \log(\frac{key}{10}) & for\ key \le 50 \\ 3 \times \log(10 - \frac{key}{10}) & for\ key \ge 60 \end{cases} \tag{2}$$

    - Mapping operation

$$I_{gm} \begin{cases} y_0 + \sqrt{r^2 - (I_{orig} - x_0)^2} & for\ key \le 50 \\ y_0 - \sqrt{r^2 - (I_{orig} - x_0)^2} & for\ key \ge 60 \end{cases} \tag{3}$$

– Global mapping curve

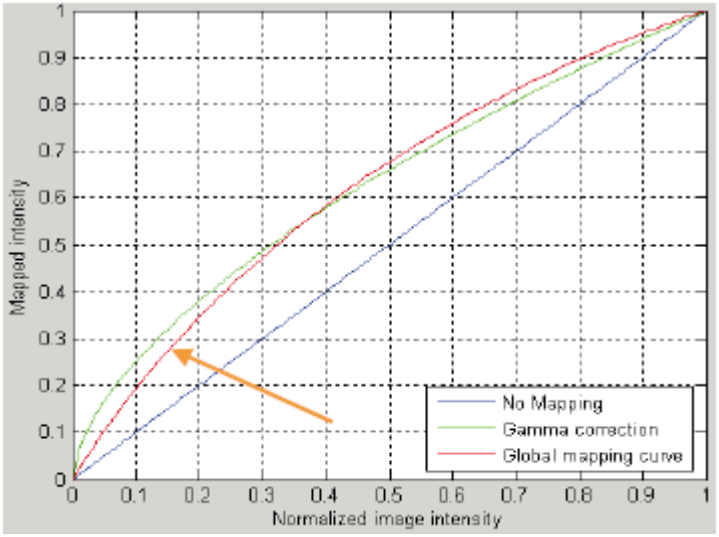

Fig. 6. Global mapping curve using an arc of circle

◆ Modified one-filter version Retinex

– Retinex Luminance

$$L_r = \frac{L_{gm}}{\log_{10}(I_m)} \tag{4}$$

– Preventing halo and blocking effect

$$I_m = L_{gm} * F_r \tag{5}$$

$$F_r = \sum_{i=1}^{\lfloor \log 2(K) \rfloor} e^{-\frac{(x^2+y^2)}{2^{2i}}} \tag{6}$$

$$K = \frac{\max(size(I))}{8} \tag{7}$$

– Example of Retinex filter

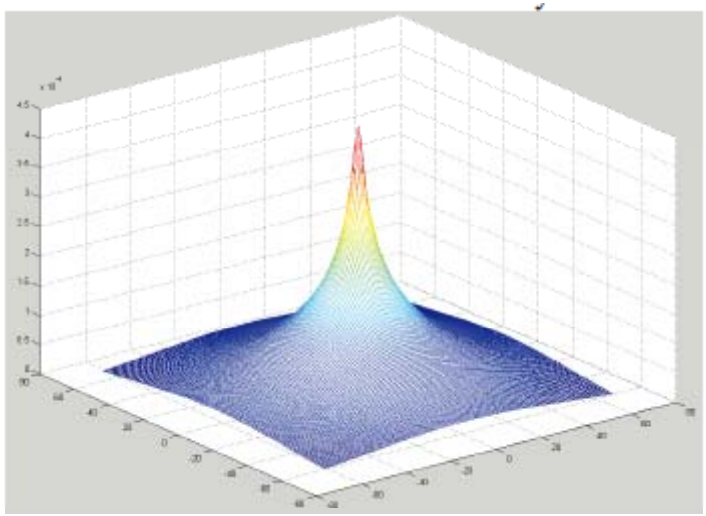

Fig. 7. Retinex filter profile

- Histogram rescaling of luminance channel
  - Using group of bright pixels
    - Histogram-based white point correction
  - Section of histogram
    - Avoiding influence of a few extreme bright pixels
- Map-based image enhancement
  - Applying Retinex independently to RGB channels
  - Use of reference map

$$M_{ref} = \log_2\left(\frac{L_{enh}}{L_{orig}}\right) + 1 \qquad (8)$$

$$I_{enh} = I_{gm} \times M_{ref} \quad with\ I = \{R, G, B\} \qquad (9)$$

- Histogram rescaling step
  - Unchanging luminance channel and chromatic component

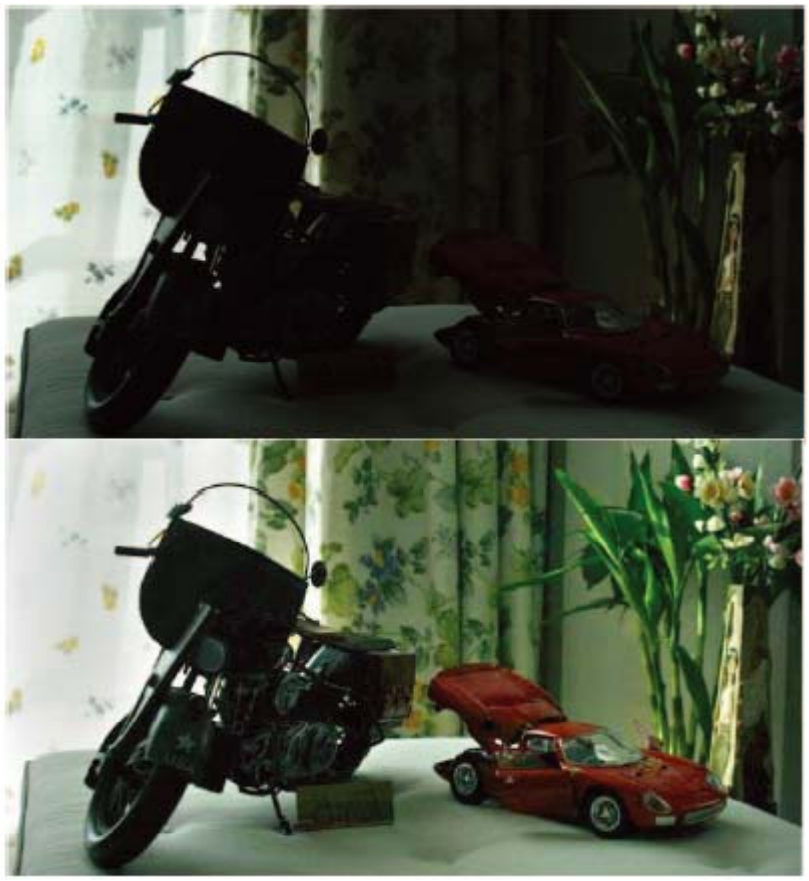

Fig. 8. Up: Original; Down: Image enhanced by NRCIR

– Result image

Fig. 9. 1st row: original image. 2nd row: results from proposed NRCIR.(Left: Low key image, Middle: HDR image, Right: High key image)

Conclusion

- Proposed method
  - New color image enhancement and color constancy algorithm
    - Based on Retinex theory
  - Comparing previous method and proposed method