Efficient Color Constancy with Local Surface Reflectance Statistics

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Introduction

- ★Inspired by the feedback modulation from horizontal cells to the cones in the retina, we first normalize each local patch with its local maximum to obtain the so-called **locally normalized reflectance estimate (LNRE)**.
- ★we experimentally found that the ratio of the global summation of **true surface reflectance** to the global summation of **LNRE** in a scene is **approximately achromatic** for both indoor and outdoor scenes.
- ★Based on this substantial observation, we estimate the illuminant directly by computing **the ratio of the global summation of the intensities to the global summation of the locally normalized intensities** of the color-biased image.

Motivation

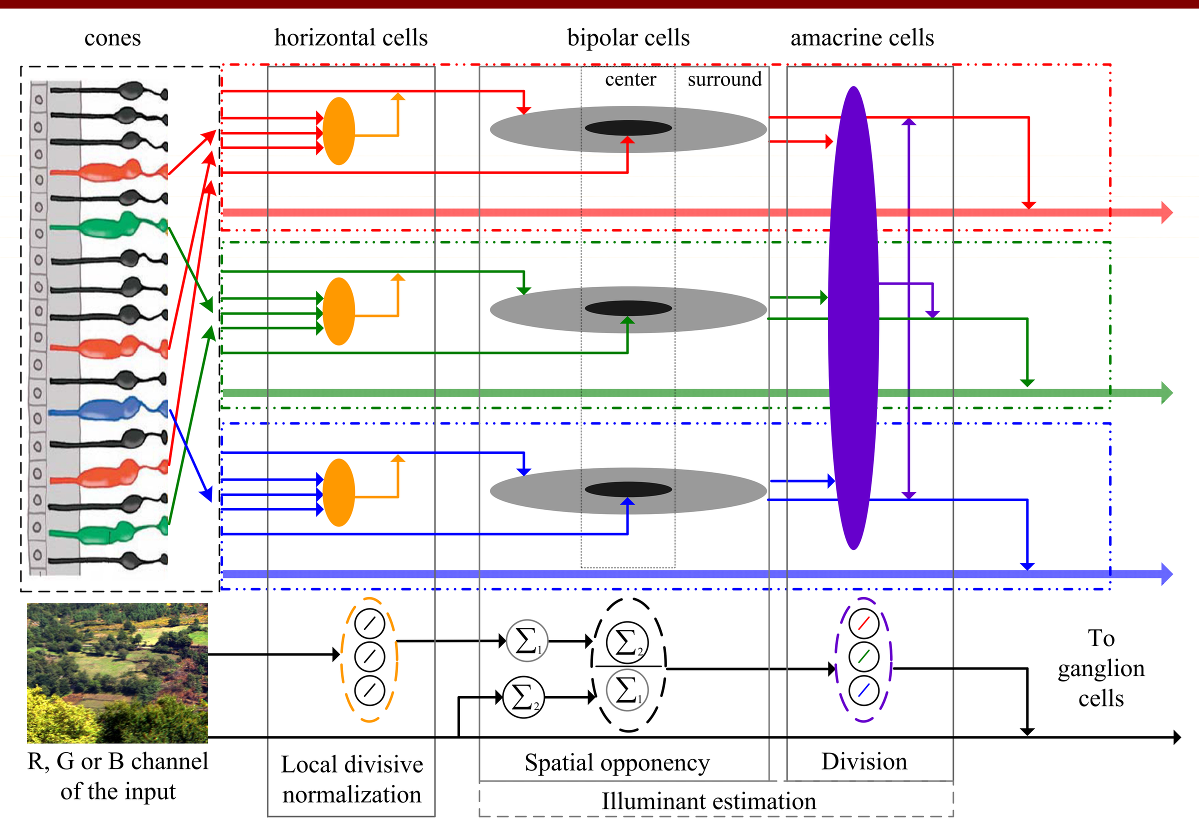


Fig.1. Retinal color constancy—a fast and efficient strategy based on divisive normalization mechanisms

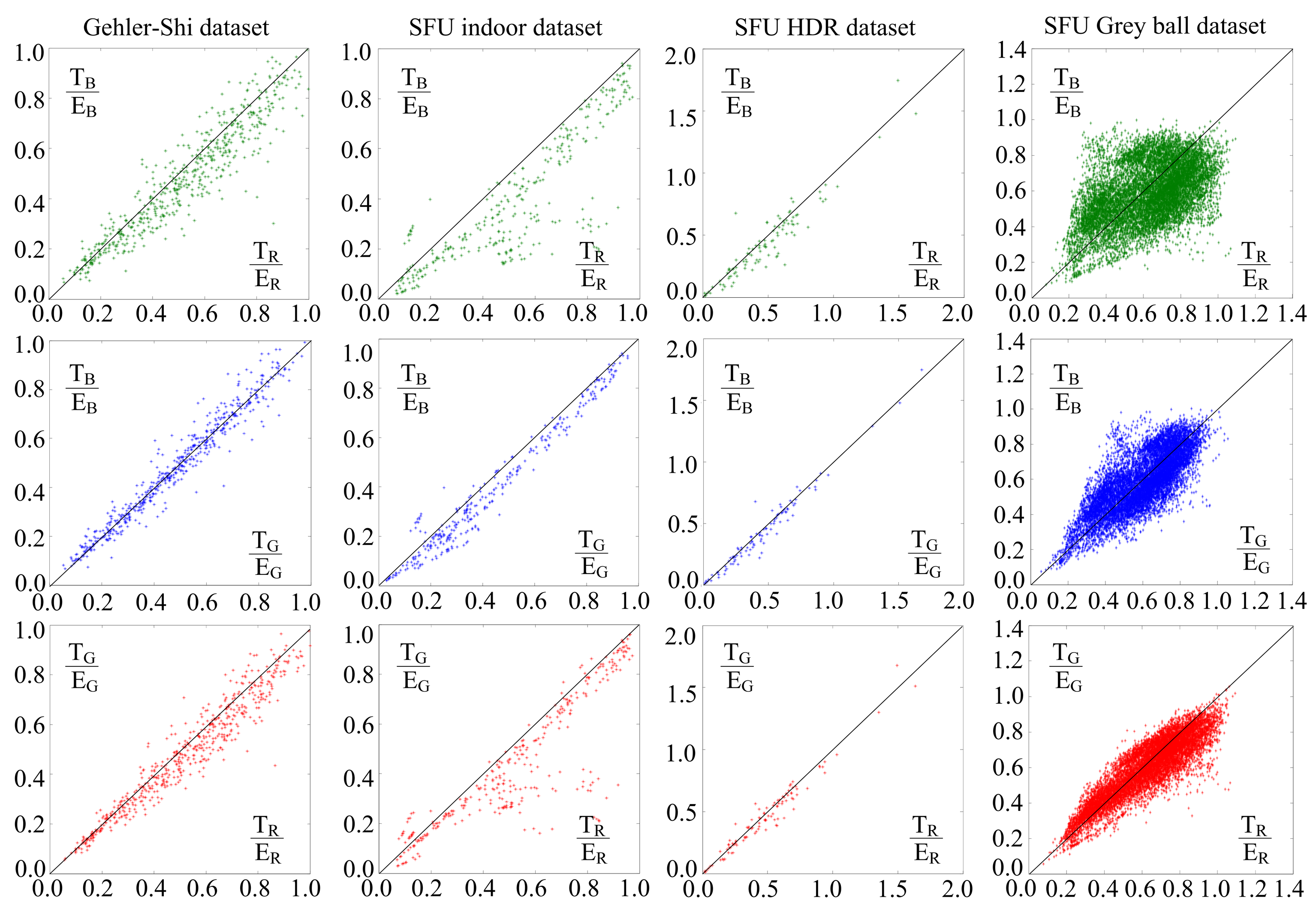
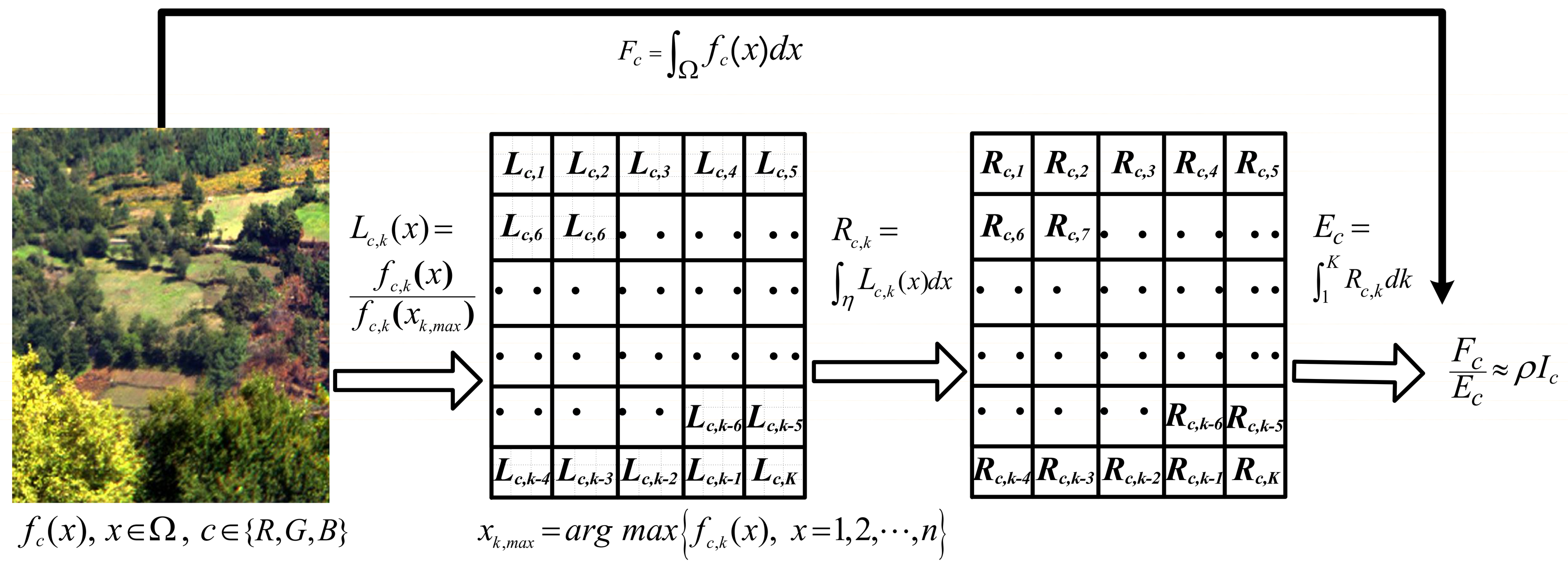


Fig.2. The **ratio** of the global summation of true surface reflectance to the global summation of locally normalized reflectance estimate in a scene is **approximately achromatic**

Model



1. Achromatic-Ratio-Mean Observation

Global sum of true reflectance → $$T_c = \int_\Omega C_c(x)dx \quad (1)$$

Global sum of locally estimated reflectance → $$E_c = \int_1^K \int_\eta L_{c,k}(x)dxdk \quad (2)$$

$$c \in \{R,G,B\}$$

The ratio of the global summation of true surface reflectance to the global summation of locally normalized reflectance estimate in a scene is approximately achromatic → $$\frac{T_R}{E_R} \approx \frac{T_G}{E_G} \approx \frac{T_B}{E_B} \approx \rho \quad (3)$$

2. Illuminant Estimation

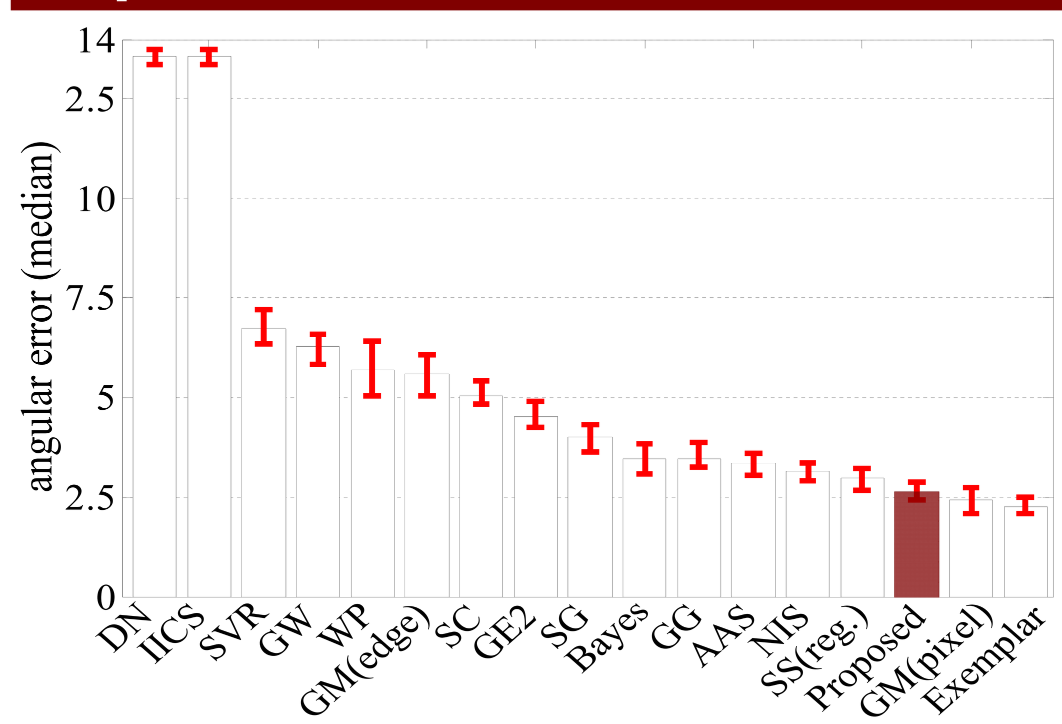
Global sum of the pixel intensities →

Global sum of the locally normalized intensities →

$$\frac{\int_\Omega f_c(x)dx}{\int_1^K \int_\eta L_{c,k}(x)dxdk} = I_c \frac{T_c}{E_c} \quad \frac{T_c}{E_c} \approx \rho \quad (4)$$

Illuminant is estimated

Experimental results



Color checker dataset

Methods	Median	Mean	Worst-25%
DN	14.7°	15.1°	19.5°
GW	7.4°	8.0°	15.1°
MaxRGB (post-blur)	3.9°	6.3°	–
SG	3.9°	5.7°	12.9°
GE	3.8°	6.0°	13.8°
CM(9 Edge-Moments)	2.7°	3.5°	–
Proposed	2.9°	4.7°	10.8°

SFU HDR dataset

Methods	Median	Mean	Worst-25%
GW	7.0°	7.9°	15.2°
DN	6.7°	8.3°	18.7°
GM(pixel)	5.8°	7.1°	14.7°
IICS	5.6°	6.6°	13.3°
WP	5.5°	6.8°	14.7°
GE2	4.9°	6.1°	13.2°
Proposed	5.1°	6.0°	11.9°

Grey ball dataset

Tab.1. **Competitive performance** comparing with multiple methods on various datasets

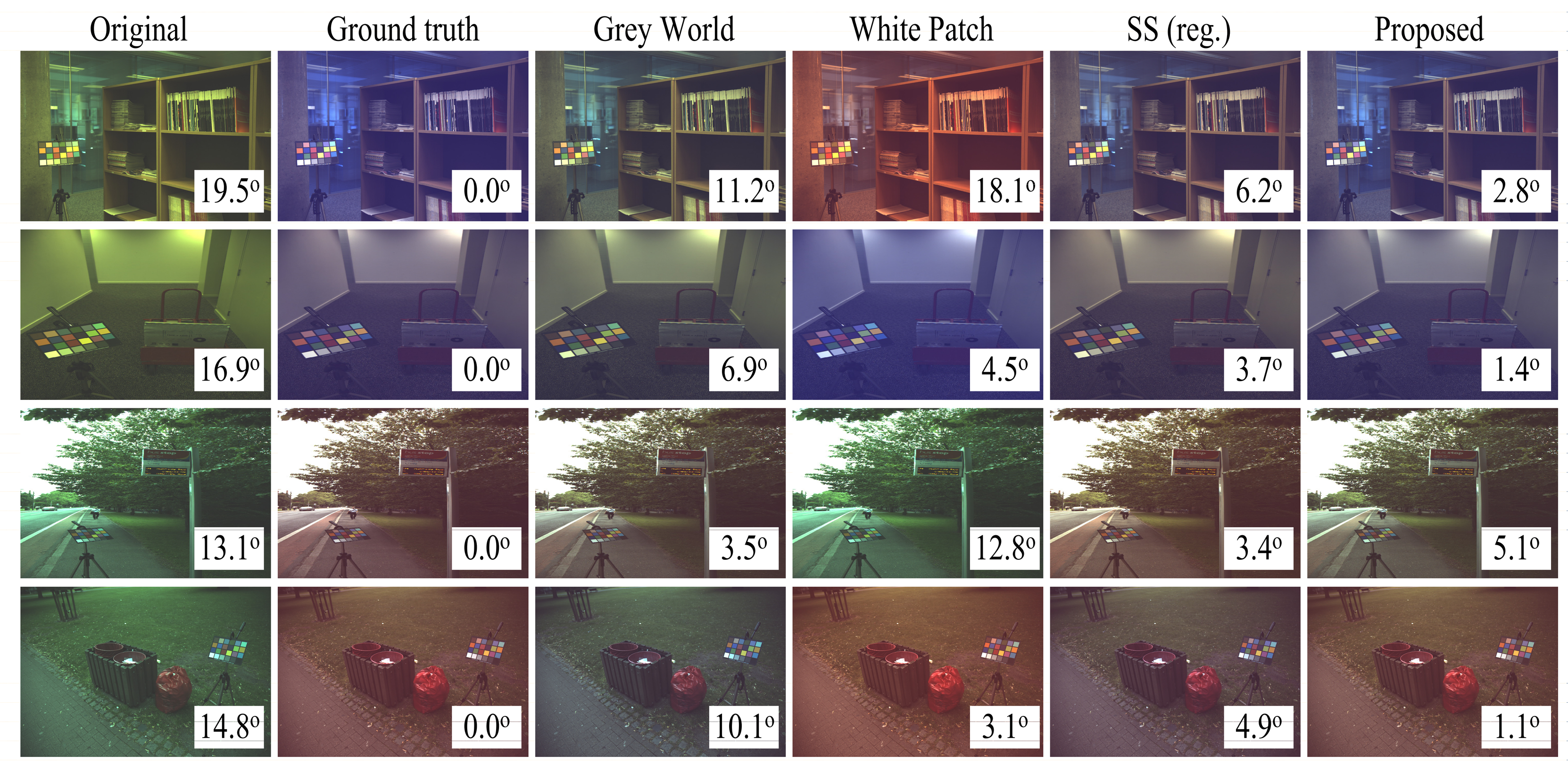


Fig.3. Images of Color checker dataset corrected with multiple methods

Dataset	GM(pixel)	GE2	Proposed
SFU grey ball dataset [9]	1.44(s)	0.27(s)	0.22(s)
Gehler-Shi dataset [32]	9.21(s)	12.90(s)	1.36(s)

Tab.2. The proposed model is **quite time saving**

Conclusion

- We built a novel color constancy model based on an interesting **Achromatic-Ratio-Mean** observation fully validated with comprehensive experimental evaluation.
- With **quite time saving implementation**, our model can produce competitive results in comparison to the state-of-the-art approaches.
- We predict that the **Achromatic-Ratio-Mean** observation may be used by our visual system, probably the retina, to rapidly discriminate the illuminant change from the surface reflectance change, which is important for defining visual color constancy.

Reference

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[4] Schiller, P.H., "Parallel information processing channels created in the retina," *Proceedings of the National Academy of Sciences* 107(40), 17087–17094 (2010)

Acknowledgement

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