Illuminant Chromaticity from Image Sequences

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Motivation

- Color constancy in ***videos*** ;
- ***Several light sources*** (*e.g.* outdoor scene at sunset) ;
- ***Color cast*** can cause vision algorithms to produce erroneous results.

First frames of a sequence recorded under two light sources

Hypothesis

- Shafer's linear model

$$I(p,t) = D(p,t) + m(p,t)L(p)$$

Scene irradiance (frame)

Diffuse term (Lambertian) constant over time.

Global illuminant uniformly distributed in time (and space).

Weighting scalar

Results

One illuminant estimation

	Average	Best 1/3	Worse 1/3
GE-1	6.5	2.1	11.2
GE-2	7.1	2.9	11.7
GGM	7.0	6.2	9.1
IIC	8.3	3.9	12.5
Ours	**5.3**	2.4	**8.7**

Angular error (in degrees)

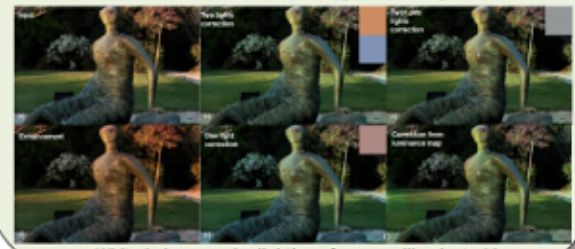
Samples from our one-illuminant dataset (1st frames)

Two illuminants estimation

Data		Ours	Local GE	Local GW
	Γ_1	**9.6**	31.6	12.9
	Γ_2	5.1	**4.8**	10.4
	Γ_1	**5.7**	9.6	5.8
	Γ_2	**4.7**	9.8	8.8
	Γ_1	**7.3**	17.9	7.6
	Γ_2	6.4	5.6	**5.7**

Angular error (in degrees)

Application : *Relighting*



White balance and relighting of a scene illuminated by afternoon sunlight and skylight (two illuminants).

The Math : One illuminant (1)

- *Temporal change of irradiance*

$$I(p+\Delta p, t+\Delta t) = I(p,t) + \Delta m(p,t)\, L$$

- *Illuminant chromaticity*

$$\frac{\Delta I_c(p,t)}{\|\Delta I\|_1} = \frac{L_c}{\|L\|_1} = x_c(p) \quad c=\{r,g,b\}$$

- *MAP estimation*

$$x_c^e = \{x_c(p) \mid \forall\, p\in\Omega_t ; p=\text{edge point}\}$$

$$\widehat{\Gamma}_c = \arg\max_{\Gamma_c} P(\Gamma_c | x_c^e)$$

Optimal global illuminant chromaticity

Typical empirical distributions P for the three channels & approx. by a Laplace distribution

The Math: Two illuminants (2)

- *Light mixture composition*

$$\Gamma_c^s = \frac{L_c^s}{\|L\|_1} = \alpha^s \Gamma_{1,c} + (1-\alpha^s)\Gamma_{2,c} \quad \alpha^s \in [0,1]$$

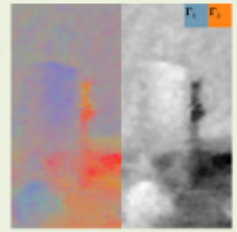
Estimated from (1) *Unknowns* *Local mixture coefficients at patch s*

- *Mixture coefficients and illuminants estimation*

$$E(\boldsymbol{\alpha}^s, \boldsymbol{a}, b) = \sum_s \left(\alpha^s - \sum_c a_c \Gamma_c^s + b\right)^2 + \epsilon\|\boldsymbol{a}\|^2$$

$$a_c = 1/(\Gamma_{1,c} - \Gamma_{2,c})$$
$$b_c = \Gamma_{2,c}/(\Gamma_{1,c} - \Gamma_{2,c})$$

$$\{\widehat{\boldsymbol{\alpha}^s}, \hat{\boldsymbol{a}}, \hat{b}\} = \arg\min E$$



$\{\Gamma^s\}$ $\{\alpha^s\}$

References

- Gijsenij & al., Generalised gamut mapping using image derivative structures for color constancy. *IJCV 2010.*
- Gijsenij & al., Color constancy for multiple light sources. *IEEE TIP 2012.*
- Tan & al., Illumination chromaticity estimation using inverse-intensity chromaticity space. *CVPR 2003*
- van de Weijer & al., Edge based color constancy. *IEEE TIP 2007.*