Color Inconstancy Index (CII):

A Proposal and Case Study for Consumer Digital Cameras

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What You Will See

- Motivation for work
- Theory
- Practice
- Results
What is it (..not) ?

- Consumer DSC performance metric
  - Scene Balance
  - White Point
- Quantitative color precision metric
- Not a color appearance metric
- Not an image quality metric
\[ \Delta E^*_{ab} \quad \text{Formulation} \]

\[ \Delta E^*_{ab} = \frac{1}{N} \sum_{i=1}^{N} \sqrt{(\Delta L_i^*)^2 + (\Delta a_i^*)^2 + (\Delta b_i^*)^2} \]

\[ \Delta L^* = \hat{L}^* - L_{aim} \quad \Delta a^* = \hat{a}^* - a_{aim} \quad \Delta b^* = \hat{b}^* - b_{aim} \]
\[
\Delta E_{94}^* = \frac{1}{N} \sum_{i=1}^{N} \sqrt{\left( \frac{\Delta L_i^*}{k_L S_L} \right)^2 + \left( \frac{\Delta C_{ab}^*}{k_C S_C} \right)^2 + \left( \frac{\Delta H_{ab}^*}{k_H S_H} \right)^2}
\]
CII Formulation

‘N’ patches
‘M’ illuminants

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CII Formulation

\[ CII = \frac{1}{N} \sum_{k=1}^{N} \left( \frac{\sigma_{L_k^*}}{2S_L} \right)^2 + \left( \frac{\sigma_{C_{abk}}}{2S_C} \right)^2 + \left( \frac{\Delta H^*_{abk}}{S_H} \right)^2 \]

\[ \sigma_{L_k^*} = \sqrt{\frac{1}{M-1} \sum_{i=1}^{M} [L_{i,k}^* - L_k^*]^2} \]

\[ \sigma_{C_{abk}} = \sqrt{\frac{1}{M-1} \sum_{i=1}^{M} [(C_{ab}^*)_{i,k} - (C_{ab}^*)_k]^2} \]

\[ \Delta H^*_{abk} = \frac{1}{M} \sum_{i=1}^{M} \Delta H^*_{abk} \]

\[ \bar{L}_k^* = \frac{1}{M} \sum_{i=1}^{M} L_{i,k}^* \]

\[ (\bar{C}_{ab}^*)_k = \frac{1}{M} \sum_{i=1}^{M} (C_{ab}^*)_{i,k} \]

‘N’ patches
‘M’ illuminants

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Experimental

- Five differently branded 2 Mpixel consumer DSCs
- Five different illuminants (2400 K – 6500 K)
- 18% integrated scene
- Macbeth target filled one-ninth the areal field of view
- Center-weighted auto-white balance mode
CII Results for Cameras Tested

![Bar chart showing CII results for Camera A, Camera B, Camera C, Camera D, and Camera E. The chart compares neutral & chromatic samples, chromatic samples, and neutral samples (zero mean a* b* aim).]
Conclusions

- Simple measure of inter-illuminant color rendering precision performance.
- Adopts accepted $\Delta E^*$ formulations.
- Consistent with visual appearances.
- Extendable to other noise or tolerance tracking needs.