Color harmonization

CVFX @ NTHU

26 Feb 2015
Outline

Color harmonization
Color harmonization and color conceptualization

“Color Harmonization” by Cohen-Or et al.

“Color Conceptualization” by Hou and Zhang
HSV color space

- Hue, saturation, value
- Non-linear
The paper

Color Harmonization

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Tel Aviv University*

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Microsoft Research Asia†

Figure 1: Harmonization in action. Our algorithm changes the colors of the background image to harmonize them with the foreground.
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Figure 1: Harmonization in action. Our algorithm changes the colors of the background image to harmonize them with the foreground.
Is automated color harmonization useful?

▶ Adobe Kuler

http://kuler.adobe.com/

▶ Applications: interior design, poster design

[Cohen-Or et al.]
Harmonic color scheme

[i type, V type, L type, I type, T type, Y type, X type, N type]

[Cohen-Or et al.]
Subjective? Objective?
Analogy to sound

- Scales, chords
Measuring the harmony

- One-dimensional optimization

\[ F(X, (m, \alpha)) = \sum_{p \in X} \left\| H(p) - E_{T_m(\alpha)}(p) \right\| \cdot S(p) \]

\[ M(X, T_m) = (m, \alpha_0) \text{ s.t. } \alpha_0 = \arg\min_{\alpha} F(X, (m, \alpha)) \]

\[ B(X) = (m_0, \alpha_0) \text{ s.t. } m_0 = \arg\min_{m} F(X, M(X, T_m)) \]
Graph cuts

- Resolving ambiguities

\[ E(V) = \lambda E_1(V) + E_2(V) \]

\[ E_1(V) = \sum_{i=1}^{\Omega} \|H(p_i) - H(v(p_i))\| \cdot S(p_i) \]

\[ E_2(V) = \sum_{\{p,q\} \in N} \delta(v(p), v(q)) \cdot S_{\text{max}}(p, q) \cdot \|H(p) - H(q)\|^{-1} \]

4- or 8-connected neighborhood

- \( \delta(v(p), v(q)) \) equals 1 if \( v(p), v(q) \) are different
Shifting colors

\[ H'(p) = C(p) + \frac{w}{2} \left( 1 - G_\sigma \left( \|H(p) - C(p)\| \right) \right) \]

\[ G_\sigma(x) = \frac{1}{\sigma \sqrt{2\pi}} \exp \left( -\frac{x^2}{2\sigma^2} \right) \in (0, 1] \]

\[ e^{-1/2} \approx 0.6065 \]
Problems mentioned by the authors

Separated regions

- Adding scribbles by users
- Semantic segmentation: important research topic in computer vision

The shifting is many-to-one

Cannot change colors with low saturation

- Only alters the hue channel
Future work mentioned by the authors

Keep certain colors unchanged, add hard constraints

Histogram matching
Color conceptualization

\[ H_I(\theta) = \sum_{i(H)=\theta} i(S) \cdot i(V) \quad i \in I \]

Kullback-Leibler Divergence

\[ D(i \parallel C) = \sum_{\theta} H_i(\theta) \log \frac{H_i(\theta)}{H_C(\theta)} \]

[Hou&Zhang]
Discussions

The methods of color harmonization & conceptualization

- How to implement these methods now?
- Graph cuts

Problem modeling

- What are the variables and parameters?
- Objective function
- How to measure harmony?
- How to measure similarities?