Optimal Transportation for Example-Guided Color Transfer

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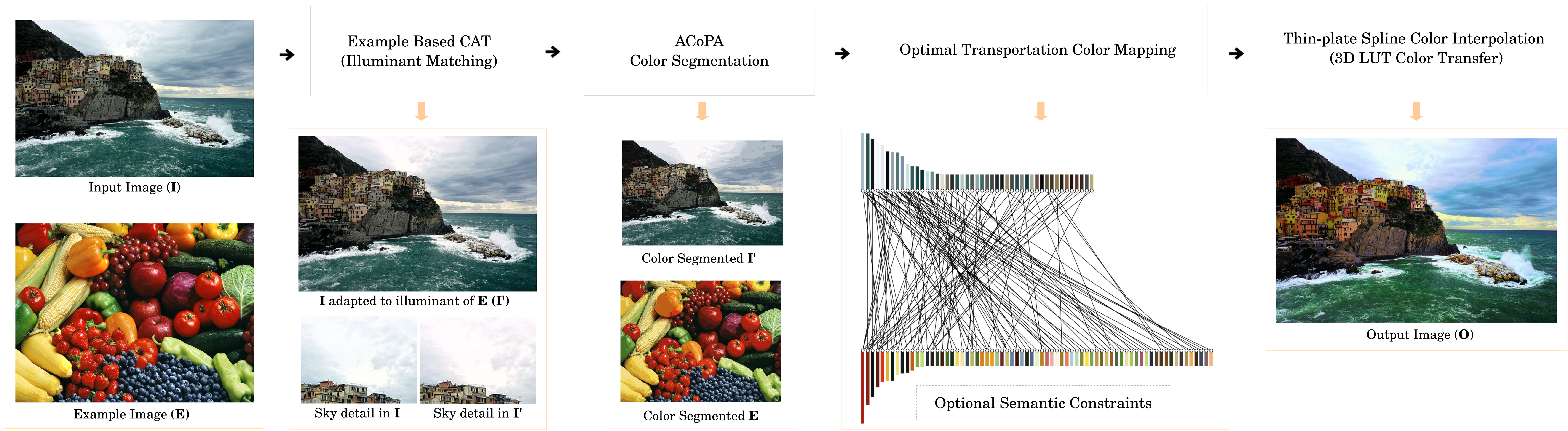


Abstract

- Example-guided color transfer is a **handy tool for easy photo editing or to assist color grading**.
- Color transfer modifies the colors of an *Input* image according to the colors of an *Example* image.
- Existent methods are prone to inconsistent color matching or to the creation of visual artifacts.
- **We present a novel and generic method** providing optimal and smooth color transfer **with no artifact generation**.
- Semantic constraints can be seamlessly incorporated in our framework.

Our Approach

1. **An example-based Chromatic Adaptation Transform (CAT) leads to an illuminant matching** between input and example images.
2. **Dominant colors are extracted from the input and example images** through Automatic Color Palette (ACoPa) segmentation [1].
3. **A mode mapping is computed through optimal transportation** and regularized through Thin plate splines.

Example-based CAT

- Given an input image I and an example image E we adapt I to the estimated illuminant of E.
- Illuminants are estimated by an iterative variant of grey world assumption.
- The diagonal transform to adapt I is given by $M = M_A^{-1} \cdot \mathrm{diag}\left(\alpha, \beta, \gamma\right) \cdot M_A$, where M_A is a CAT matrix, α, β, γ are independent illuminant ratios of E and I.

Optimal Color Chroma Transfer

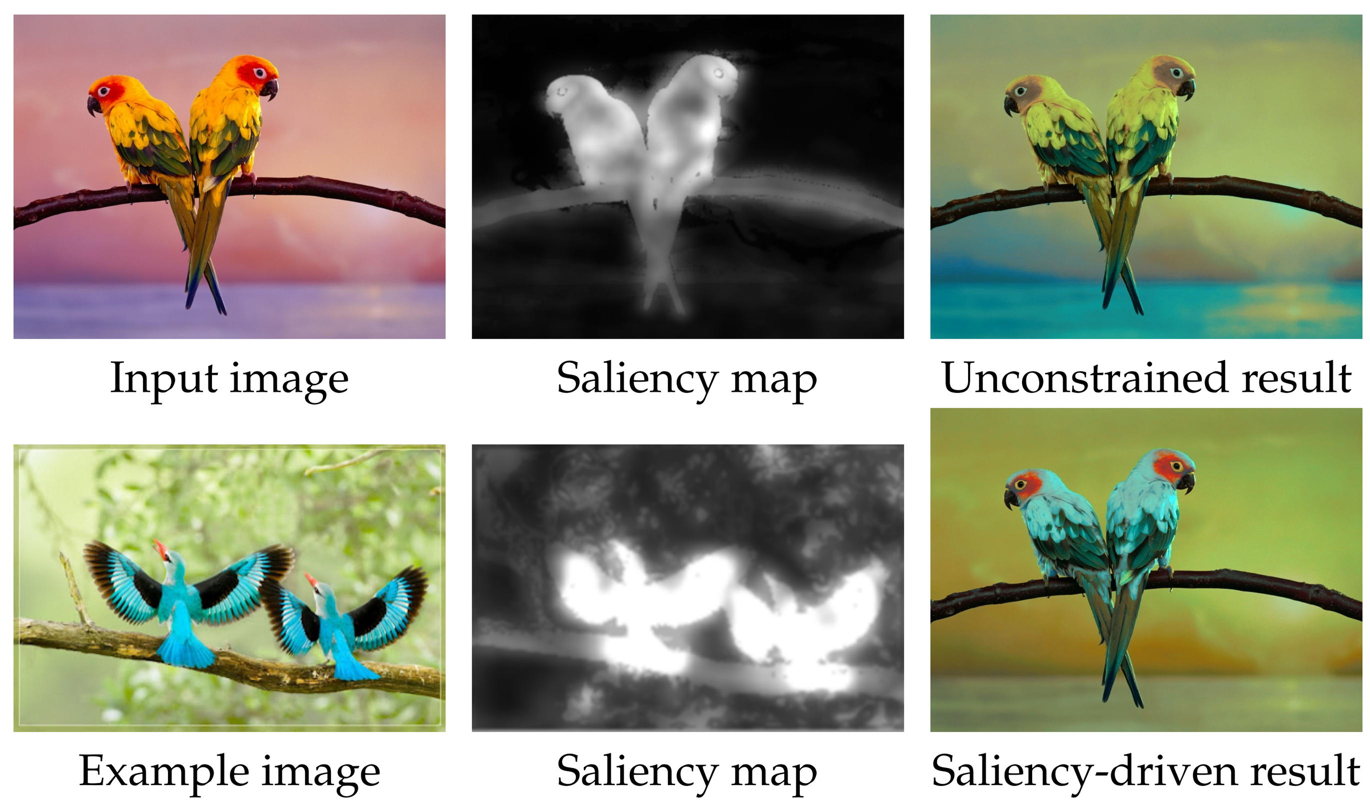
- Let $P = \{\mathbf{p}_i\}_{i \in [1,m]}$ and $Q = \{\mathbf{q}_j\}_{j \in [1,n]}$ be the input and example set of color modes.
- Let $\mathbf{D} = [d_{ij}]$ be a color distance matrix for each mode in P and Q: $d_{ij} = \|\mu_i - \mu_j\|_2 + \|\sigma_i - \sigma_j\|_2$.

1. We find the transport plan $\mathbf{F} = [f_{ij}]$ that minimizes $\sum_{i=1}^{m} \sum_{j=1}^{n} f_{ij} d_{ij}$.
2. For each input mode $i = 1, \ldots, m$, we compute a corresponding mapped color $\widehat{\mu}_i^k = \frac{\sum_{j=1}^{n} f_{ij} \mu_j^k}{\sum_{j=1}^{n} f_{ij}}$, where $k = \{a, b\}$ are chroma channels in CIELAB color space.
3. The final color transfer is computed as a 3D thin plate splines interpolation of color correspondences $\Upsilon = \left\{ (\mu_i^a, \mu_i^b), (\widehat{\mu}_i^a, \widehat{\mu}_i^b) \right\}_{i=1,\ldots,m}$.

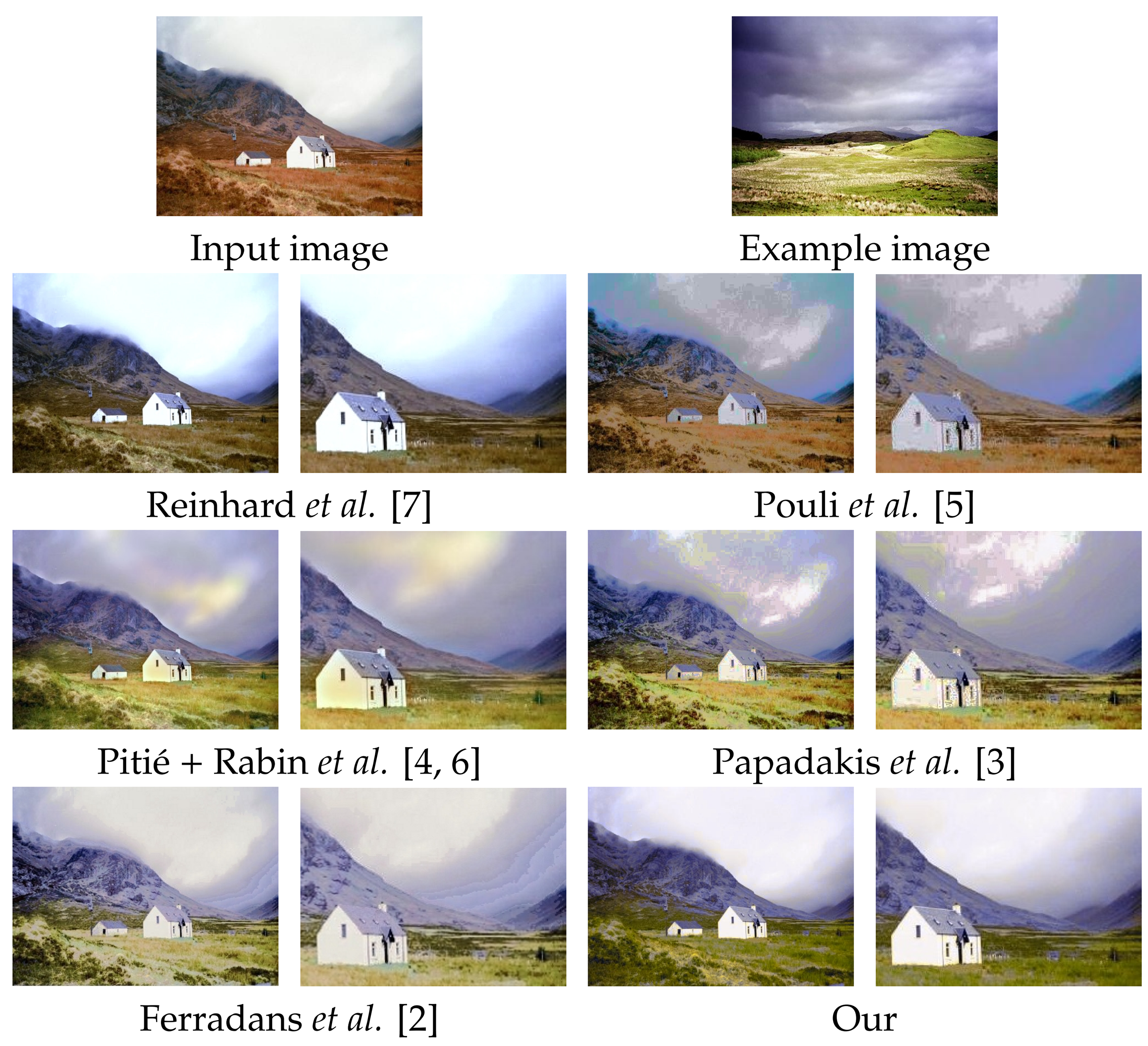
Semantic Constraints

- The color modes P and Q can be separated into two classes $P = \{\hat{P} \cup \tilde{P}\}$ (resp. $Q = \{\hat{Q} \cup \tilde{Q}\}$) based for instance on visual attention (mapping salient colors).
- Color mappings g and h represent can be computed solving two different transportation problems:

$$g : \hat{P} \to \hat{Q}, \text{ and } h : \tilde{P} \to \tilde{Q}.$$



Experimental Comparison



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