OPTIMIZING COLOR CONSISTENCY IN PHOTO COLLECTIONS.

HELLO!

We are Group 17

-Alakh Desai : 201530033

-Ashwin Pathak : 201501056

-Omkar Miniyar : 201530217

LINK :
http://www.cs.huji.ac.il/~yoavhacohen/color-consistency/color-consistency-light.pdf

1.

AIM

WE AIM TO ACHIEVE THE FOLLOWING :

- To ensure a consistent appearance of connected photos without user explicitly doing it on every single photo.

- It is achieved by globally optimizing a quadratic cost function over the entire graph.

Figure 1: *Editing a photo collection with our method. First row: input images exhibiting inconsistent appearance. Red arrows indicate pairs of images that were detected to share content. Second row: automatically induced consistent appearance. Third row: after propagating user adjustment of the leftmost photo (photos with similar content are affected more strongly). Fourth row: propagation of an adjustment done to the sixth photo. Previous adjustment remains as constraint. (Note: adjustments are deliberately exaggerated in this example.)*

CAUSES FOR **INCONSISTENCIES**

- Changes in Lighting Conditions.
- Changes in Camera Settings.
- Changes due to different Cameras altogether.

CONSTRAINTS

In the process of imposing color consistency, we attempt to balance between achieving color consistency and preserving the dynamic range and natural appearance of individual photos.

2.

AVAILABLE WORKS

MANY RELATED **WORKS** ARE AVAILABLE LIKE

Adobe Photoshop

There are many tools such as Auto Levels tool in Adobe Photoshop which are robust but these tools operate on each image independently.

Propagation Techniques

Many researchers have come up with several techniques to propagate appearance between images but they evolve around 3-D reconstruction. They are also confined to static and cannot be extended to wide variety of photo collections.

3.

NON-RIGID DENSE CORRESPONDENCE (NRDC)

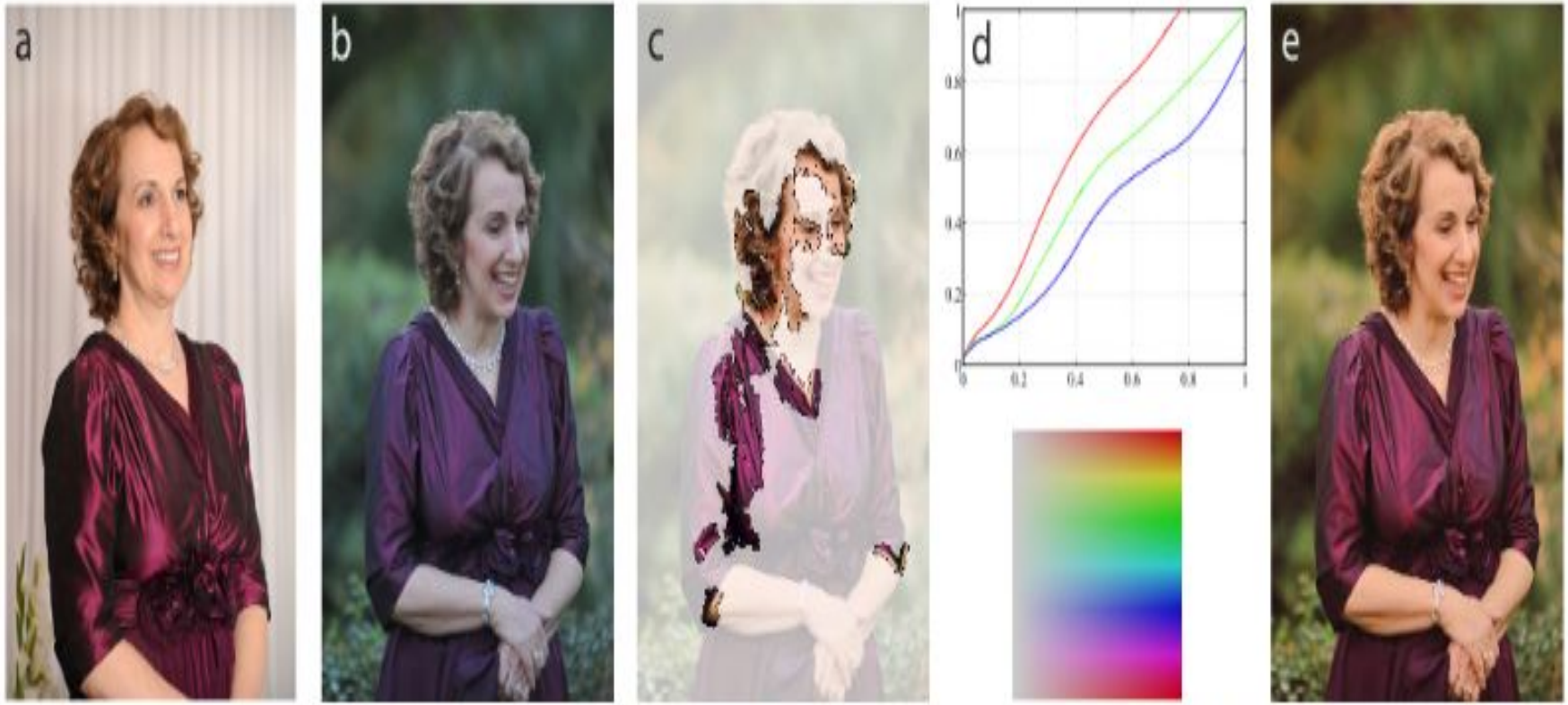
LINK : http://www.cs.huji.ac.il/~yoavhacohen/nrdc/

WHAT IS NRDC AND HOW IS IT HELPFUL ?

- NRDC is a state-of-the-art method for finding corresponding regions and color transfer between two photos that share common content.

- This method can handle shared content under non-rigid deformations and color variations, and computes a parametric color transfer model between pairs of images.

- We utilize a new coarse-to-fine scheme in which nearest-neighbor field computations using Generalized PatchMatch are interleaved with fitting a global nonlinear parametric color model and aggregating consistent matching regions using locally adaptive constraints.



Color transfer using our method. The reference image (a) was taken indoors using a flash, while the source image (b) was taken outdoors, against a completely different background, and under natural illumination. Our correspondence algorithm detects parts of the woman's face and dress as shared content (c), and fits a parametric color transfer model (d). The appearance of the woman in the result (e) matches the reference (a).

4.

APPEARANCE
CONSISTENCY
OPTIMIZATIO
N

- Let, I_j be the Img which we are Changing & f_j be the intensity transform for I_j.
- The effect on other Images is represented by the f_is Which calculated by following optimization problem.

$$\{\hat{f}_i\}_{i=1}^{n} = \underset{\{f_i\}_{i=1}^{n}}{\arg\min} \sum_{i \neq j} A(f_i, f_j) + \sum_{i=1}^{n} C_{soft}(f_i) \qquad (1)$$

$$\text{subject to: } C_{hard}(f_i), \forall i \in \{1, \ldots, n\}$$

- **Color Transformation Model**
  - The color transformations f_i is based on an expressive global parametric model.
  - Each f_i consists of three curves (one per each RGB channel). Each curve is a smooth piecewise-quadratic spline with 6 knots at (0, 0.2, 0.4, 0.6, 0.8, 1), which translates to 7 degrees of freedom per curve.

- **$A(f_i,f_j)$** - Pairwise affinity term, penalizing color diff. between shared content

- **$C_{Soft}(f_i)$ & $C_{Hard}(f_i)$** - Term enforcing constraints on the color transformations

$C_{soft}(f_i)$

$$\begin{aligned} C_{soft}(f_i) &= \lambda_1 \sum_{x\in\{0,1\}} |f_i(x)-x|^2 \\ &+ \lambda_2 \sum_{x\in\{0.2j-0.1\}_{j=1}^{5}} |f_i(x)-x|^2 \\ &+ \lambda_3 \sum_{x\in\{0.2j-0.1\}_{j=1}^{5}} |f_i''(x)|^2. \end{aligned} \quad (2)$$

- λ_1 and λ_2 control how much to pull the curve towards identity at the end points of the range and at five midpoints between the knots.

- λ_3 controls the smoothness of the curve by penalizing for large second derivatives.

$C_{hard}(f_i)$

$$C_{hard}(f_i): \text{ i. } 0.2 \le f_i'(x) \le 5, \quad \forall x \in \{0.2j-0.1\}_{j=1}^{5} \quad (3)$$
$$\text{ii. } f_i(0) \le 0$$

- The curve is forced to be strictly monotonic (at the spline segment midpoints).

AFFINITY TERM

The pairwise affinity term $A(f_i,f_j)$ is defined using the weighted SSD (sum of squared differences) between color-mapped pairs of matching pixels.

$$A(f_i, f_j) = \sum_{\mathbf{p}} w_{i,j}(\mathbf{p}) \left| f_i(I_i(\mathbf{p})) - f_j(I_j(M_{i,j}(\mathbf{p}))) \right|^2 \qquad (4)$$

- $M_{i,j}: N^2 \rightarrow R^2$ is partial pixel-wise mapping that maps pixels in I_i to I_j
- $w_{i,j}: N^2 \rightarrow [0, 1]$ is the confidence map associated with this mapping.

5.

TECHNOLOGIES

- MATLAB
  - Basic Implementation
  - NRDC
  - Splines Generation Tools : (ppmak, ppval to be specific)
  - CVx Solver (for solving optimizations problems)

6.

WORKFLOW

OUR **PROCESS** IS

Apply NRDC on all images with the reference image.

Apply appearance consistency optimization and obtain best transformations for all images.

Transform all the images to obtain the color consistency among all images.

7.

RESULTS

WE **OBSERVED** THE FOLLOWING

- Images with high intensity coherency had a dense correspondence.

- Images with dense correspondence were observed to have more transform as compared to the ones with sparse or zero correspondence.

- The time for making the dense graphs and its further propagation is time consuming, hence, we need an even better mechanism to predict the links and propagate.

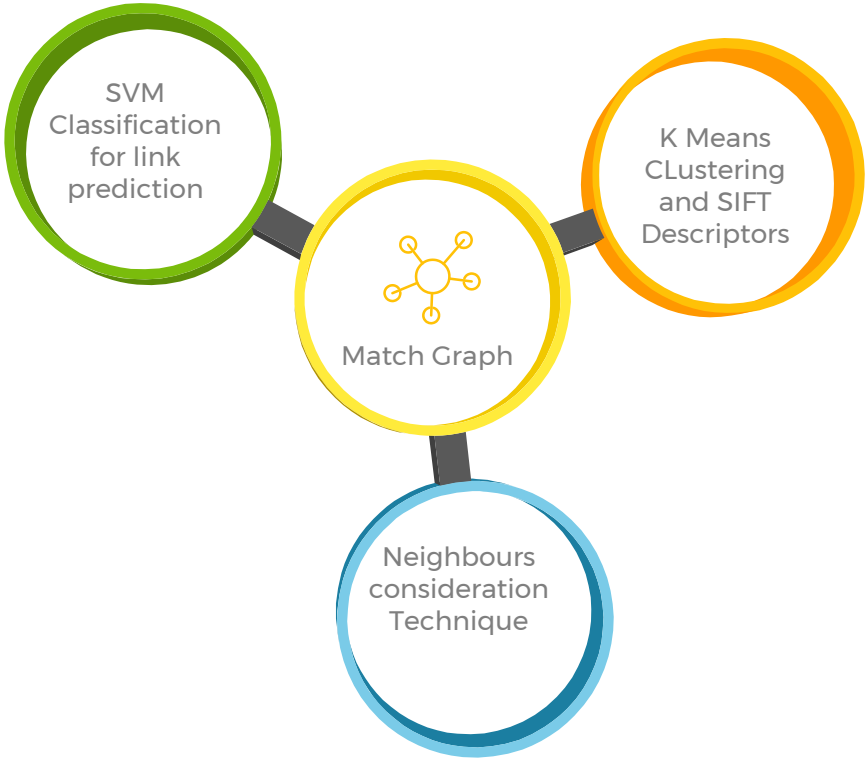
RESULTS

8.

ACCELERATING MATCH GRAPH CONSTRUCTION

FUTURE WORK AND SCOPE

WE CAN USE THE FOLLOWING **TECHNIQUES** TO ACCELERATE MATCH GRAPH CONSTRUCTION



LIMITATIONS

- Our method currently accounts for global color appearance variations only.
- Our color transfer model is based on RGB curves and does not model saturation changes well.
- Our method works best when the collection contains a substantial amount of shared content, as typically occurs in personal and professional collections.

THANKS!

Any questions?