Two-scale Tone Management for Photographic Look

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Ansel Adams

Ansel Adams, *Clearing Winter Storm*
An Amateur Photographer
A Variety of Looks
Goals

- Control over photographic look
- Transfer “look” from a model photo

For example,

we want with the look of
Aspects of Photographic Look

- Subject choice
- Framing and composition
  ➔ Specified by input photos
- Tone distribution and contrast
  ➔ Modified based on model photos
Tonal Aspects of Look

Ansel Adams

Kenro Izu
Tonal aspects of Look - Global Contrast

Ansel Adams

Kenro Izu

High Global Contrast  Low Global Contrast
Tonal aspects of Look
- Local Contrast

Ansel Adams

Kenro Izu

Variable amount of texture
Texture everywhere
Related Work - Tone Mapping

- Reduce global contrast
  [Pattanaik 98; Tumblin 99; Ashikhmin 02; Durand 02; Fattal 02; Reinhard 02; Li 05]
- Seeks neutral reproduction
  - Little control over look

In contrast,
we want to achieve particular looks
Related Work – Professional tools

- Image editing software
  e.g. Adobe Photoshop
  - need skills
  - tedious

- Photo management tools
  e.g. Adobe Lightroom, Apple Aperture
  - optimizes user efficiency (workflow)
  - but has limited control
Our work

- Transfer look between photographs
  - Tonal aspects
Our work

- Separate global and local contrast

Input Image

Global contrast

Local contrast

Result
Overview

**Input Image**

Split

Global contrast

Careful combination

Local contrast

Result

Post-process
### Overview

**Input Image**

**Global contrast**

- Split
- Careful combination
- Post-process

**Local contrast**

**Result**
Split Global vs. Local Contrast

- Naïve decomposition: low vs. high frequency
  - Problem: introduce blur & halos

Low frequency **Global contrast**

High frequency **Local contrast**
Bilateral Filter

- Edge-preserving smoothing [Tomasi 98]
- We build upon tone mapping [Durand 02]

![After bilateral filtering](image1)

**Global contrast**

![Residual after filtering](image2)

**Local contrast**
Bilateral Filter

- Edge-preserving smoothing [Tomasi 98]
- We build upon tone mapping [Durand 02]

After bilateral filtering

Global contrast

BASE layer

DETAIL layer

Residual after filtering

Local contrast
Global contrast

Input Image

Bilateral Filter

Local contrast

Careful combination

Post-process

Result
Global contrast

Input Image

Bilateral Filter

Careful combination

Post-process

Result

Local contrast
Global Contrast

- Intensity remapping of base layer

Input base

Remapped intensity

Input intensity

After remapping
Global Contrast (Model Transfer)

- Histogram matching
  - Remapping function given input and model histogram
**Global contrast**

**Input Image**

[Image of input image]

**Bilateral Filter**

[Image of bilateral filter output]

**Intensity matching**

[Image showing intensity matching]

**Careful combination**

[Image showing combination]

**Post-process**

[Image of post-process output]

**Result**

[Image of final result]
Local contrast

Global contrast

Input Image

Bilateral Filter

Intensity matching

Careful combination

Post-process

Result
Local Contrast: Detail Layer

- Uniform control:
  - Multiply all values in the detail layer

Input

Base + 3 × Detail
The amount of local contrast is not uniform
Local Contrast Variation

- We define “textureness”: amount of local contrast at each pixel based on surrounding region.

Smooth region ⇒ Low textureness
Textured region ⇒ High textureness
“Textureness”: 1D Example

Previous work: Low pass of $|H|$ [Li 05, Su 05]

Input signal → High frequency $H$ → Amplitude $|H|$ → Edge-preserving filter
Textureness

Input

Textureness
Texturelessness Transfer

Step 1:
Histogram transfer

Model

Input

Desired

Hist. transfer

Input detail

Output detail

Step 2:
Scaling detail layer (per pixel) to match desired textureness

x 0.5

x 2.7

x 4.3
Global contrast

Input Image

Bilateral Filter

Intensity matching

Careful combination

Textureness matching

Local contrast

Post-process

Result
Global contrast

Input Image

Bilateral Filter

Intensity matching

Textureness matching

Careful combination

Local contrast

Post-process

Result
A Non Perfect Result

• Decoupled and large modifications (up to 6x)
  ➜ Limited defects may appear
Intensity Remapping

- Some intensities may be outside displayable range.
  ➔ Compress histogram to fit visible range.
Preserving Details

1. In the gradient domain:
   - Compare gradient amplitudes of input and current
   - Prevent extreme reduction & extreme increase

2. Solve the Poisson equation.
Effect of Detail Preservation

uncorrected result  corrected result
Global contrast

Intensity matching

Bilateral Filter

Constrained Poisson

Input Image

Textureness matching

Local contrast

Post-process

Result
Global contrast

Input Image

Bilateral Filter

Intensity matching

Textureness matching

Local contrast

Constrained Poisson

Post-process

Result
Additional Effects

- **Soft focus** (high frequency manipulation)
- **Film grain** (texture synthesis [Heeger 95])
- **Color toning** (chrominance = $f'(luminance)$)
Intensity matching

Bilateral Filter

Global contrast

Intensity matching

Constrained Poisson

Soft focus
Toning
Grain

Input Image

Local contrast

Textureness matching

Result
Recap

Global contrast

Intensity matching

Bilateral Filter

Constrained Poisson

Soft focus Toning Grain

Local contrast

Textureness matching

Result

Input Image
Results

User provides input and model photographs.

➔ Our system automatically produces the result.

Running times:

- 6 seconds for 1 MPixel or less
- 23 seconds for 4 MPixels
  - multi-grid Poisson solver and fast bilateral filter [Paris 06]
Input

Model
Result
Comparison with Naïve Histogram Matching

Local contrast, sharpness unfaithful
Comparison with Naïve Histogram Matching

Input

Model
*Clearing Winter Storm, Ansel Adams*

Histogram Matching

Our Result

Local contrast too low
Color Images

- Lab color space: modify only luminance
Limitations

- Noise and JPEG artifacts
  - amplified defects

- Can lead to unexpected results if the image content is too different from the model
  - Portraits, in particular, can suffer
Conclusions

• Transfer “look” from a model photo

• Two-scale tone management
  - Global and local contrast
  - New edge-preserving textureness
  - Constrained Poisson reconstruction
  - Additional effects