Better Photos

BIL721: Computational Photography
Spring 2015, Lecture 11

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Today’s Agenda

• What makes a good picture?
  – The Design of High-Level Features for Photo Quality Assessment, Ke et al., 2006

• Tone Style Enhancement
  – Two-scale Tone Management for Photographic Look, Bae et al., SIGGRAPH 2006
  – Style Transfer for Headshot Portraits, Shih et al., SIGGRAPH 2014
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Making better photos
Not a creativity session

- For those of us who are NOT talented photographers
- Heuristics, issues, that help get better photographs. Maybe not great photographs, but better
- If you are talented, good for you. Forget those “rules”, keep taking good photos.
Advice overview

• Simplify, avoid cluttered background
• Don’t center things
• Avoid harsh light
• White balance
• Portraits are all about the eyes
• Follow rules or really break them. No middle ground.
Cluttered backgrounds are bad
Distracting background
Move your feet! (1 meter away)
Distracting background

50mm f/8
Shallower depth of field

50mm f/1.8

Model: Rob Wang
Shallower depth of field

85mm f/1.2

Model: Rob Wang
Isolate using blur (Photoshop, layering)

- But maybe don’t over-do it
Clone brush/Poisson cleaning
Desaturate, darken

Problem...

Background distractions
In the chaos of a young child’s room, it is neither possible nor desirable to remove all the distractions, but toning them down would help to emphasize the main subject.
- Bronica SQ-A with 40 mm lens. ISO 64 film. Heidelberg Saphir II scanner.

Desaturated background
Applying Desaturate to the background, turning all the colors into gray has helped separate the girl from the numerous objects surrounding her. A large, soft-edged Brush tool was chosen and the printing mode was set to desaturation at 100 percent.

From Digital Photographer’s Handbook
Fixing a cluttered background

• Change viewpoint
• Shallow depth of field
• Frame tighter
• Modify scene (move objects, add backdrop)
• Retouch (blur, desaturate, darken)
Composition
Get low

- Try to be at eye level

Bad

Better
Eye level
Or really get high

- As usual, follow a rule or really break it.
The rule of thirds is a guideline developed by artists centuries ago. When the subject—or its most important element—is placed near one of the intersecting points of an imaginary grid, the viewer’s eye is led through the frame. The result is an aesthetically strong image.
Rule of the thirds
Rule of the Third

slide by Fredo Durand
Don’t center, especially for motion
Don’t center, especially for motion
Don’t center, especially for motion
... or do center

Slide by Frédéric Durand
Build on diagonal lines
Try unusual angles

• Do or don’t:
  Either perfectly vertical or at least 30 degrees

Try Unusual Angles
Be bold! Try turning your camera to 45 degrees before snapping a picture. Or instead of snapping it from eye level, kneel down or lie on the ground to get a more interesting shot.

http://www.fotofinish.com/resources/centers/photo/takingpictures.htm
Light
Bottom line

• Don’t get married on a sunny day!
Go in the shade

- Light is more diffuse

Bad

Better
Overcast days are the best

• Just don’t put the sky in the frame

The weather conditions

The pictures

Other overcast-day pictures
Best time of day: sunset & sunrise

- +/- 1 hour
- “Golden hours”
- Night photography: always near sunset/sunrise – because of nice diffuse light

Mid day: often not great
less than 1 hour after sunrise/ before sunset
During sunset or sunrise
After sunset
During sunset/sunrise

After sunset

less than 1 hour after sunrise
• 10 minutes after sunset
Add fill flash

- For harsh lighting conditions
- Illuminate shadows with flash to reduce dynamic range
- But set the flash to -1.5 or -2 EV (3 to 4 times darker than existing lighting)

Use flash outdoors

Bright sun can create unattractive deep facial shadows. Eliminate the shadows by using your flash to lighten the face. When taking people pictures on sunny days, turn your flash on. You may have a choice of fill-flash mode or full-flash mode. If the person is within five feet, use the fill-flash mode, beyond five feet, the full-power mode may be required. With a digital camera, use the picture display panel to review the results.

On cloudy days, use the camera’s fill-flash mode if it has one. The flash will brighten up people’s faces and make them stand out. Also take a picture without the flash, because the soft light of overcast days sometimes gives quite pleasing results by itself.

Learn more about composing people pictures

Without flash
With fill flash
How to recognize the good photos

[Ke 06]
What makes one photo better than another?

- Simplicity
- Realism
- Basic photographic techniques
Simplicity

Prof - Obvious what one should be looking at i.e. easy to separate subject from the background.
Snap – unstructured, busy, filled with clutter.

“Look Into” by Josh Brown @ Flickr

slide by Alyosha Efros
Simplicity

“alien flower” by Josef F. Stuefer @ Flickr
Simplicity

“Waiting in line!” by Imapix @ Flickr
Basic techniques

• Blur  Snaps – entire photo blurry indicates poor technique. Prof – background out of focus by widening the lens aperture, but foreground in sharp focus.

• Contrast and brightness • Make the subject pop out by choosing complementary colors for subject & background.
  • Isolate the subject by increasing lighting contrast between subject & background.

Abstract concepts - “Good composition, color & lighting”
(Sur)Realism Snaps look real, while prof photos look surreal.

“Golden Gate Bridge at Sunset” by Buzz Andersen @ Flickr

“Golden Gate 3” by Justin Burns @ Flickr
Techniques (human)

• **Lighting conditions**
  - time of day (morning, dusk), colored filters to adjust color balance (make sky bluer, sunset more brilliant), careful color selection of scene

• **Camera settings**
  - adjust settings like focal length, aperture, shutter speeds to modify mood, perspective. E.g. might use long shutter speed to capture waterfall and give a misty look

• **Subject matter**
  - ordinary objects in unusual poses or settings (challenging since would need object recognition first)
Features – Spatial Distribution of Edges

More edges near border due to background clutter

More edges near center of img

“Picture of a picture…” by Ted Johnson @ Flickr

Trying to capture a photo’s “simplicity”
Spatial Distribution of Edges

Mean Laplacian of snapshots

Mean Laplacian of professional

More uniformly distributed

More concentrated

Low quality photos

High quality photos

• Expect high quality photos to have high spatial frequency edges nearer to center than snapshots
Edge width

- Calculate area that edges occupy – width of bounding box covering 96% of edge energy
- Cluttered regions should tend to produce a larger bounding box, and well defined subjects should produce a smaller one.

.94  .56
Color Distribution

• K-NN on color histogram

For query image find $k$ nearest neighbors in training set. Quality = # of professional neighbors in top 5.

$q_{cd} = \# \text{ professional_neighbors}$
Hue Count

20 bin histogram defining possible unique hues

Hue Count

$q_h = 20 - (# \text{ hues} > \text{threshold})$

# unique hues smaller for prof photos even though they tend to look more vibrant and colorful (S,V may vary more) – another measure related to “simplicity”
Most unlikely colors...

From Lalonde and Efros, ICCV’ 2007
Prof photos should have some part of photo in sharp focus.

- Look at frequency distribution.
- Measure the amount of blur in the sharpest object, instead of the average blur.
Prof photos usually have higher contrast

Contrast = width of middle 98% mass of hist
Contrast

$p(x)$

0 255

Contrast (98\% mass)
• Professional photographers may adjust exposure to be correct on subject only so subject pops from background.
• Cameras tend to adjust brightness to average at 50% gray, but prof photos might deviate significantly.
• Use average brightness as feature.
Classifier

- Naives Bayes
- We assume independence of the features
- We achieve better results with added features even though they are not independent.
Dataset – DPChallenge.com

Use photos average rating as ground truth quality measure

Use only top 10%, bottom 10% as dataset.

Use half for training/half for testing.

Photo contest website, user rated

60K photos
40K photographers
10/90 percentile
Difficulty of Dataset

![Graph showing difficulty of dataset]
Results

\[ \text{recall} = \frac{\# \text{ professional photos above threshold}}{\text{total } \# \text{ professional photos}} \]

\[ \text{precision} = \frac{\# \text{ professional photos above threshold}}{\# \text{ photos above threshold}}. \]
Most Distinctive Feature: Blur

- A *badness* metric, rather than a *goodness* metric.
Results

72% classification rate
Web Retrieval Results
Web Retrieval Results
Related Concepts

- **Image memorability** [Isola 11; Khosla 12; Celikkale 13; Khosla 13]
- **Image interestingness** [Dhar 11; Gygli 13]
- **Image popularity** [Khosla 14]
- **Image specificity** [Jas 15]
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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

Variable amount of texture

Texture everywhere
Related Work

– Example-based style transfer

• Non-photorealistic styles

[Hertzmann 01; Efros 01; Drori 03; Rosales 03]

– mimics brush strokes or textures

✗ but does not target photorealistic style

![A](image1)

![A’](image2)

![B](image3)

![B’](image4)

[Hertzmann 01]
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
The Approach

- Transfer look between photographs
  - Tonal aspects
The Approach

• Separate global and local contrast
Overview

Input Image

Global contrast

Split

Local contrast

Careful combination

Post-process

Result
Overview

Input Image

Global contrast

Local contrast

Careful combination

Split

Result

Post-process
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
**Global contrast**

Residual after filtering
**Local contrast**
Bilateral Filter

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

Input Image

Global contrast

Careful combination

Post-process

Result

Local contrast

Input Image
Global contrast

Input Image → Bilateral Filter → Local contrast → Careful combination → Result

Post-process
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

Intensity matching

Bilateral Filter

Local contrast

Careful combination

Post-process

Input Image

Result
Global contrast

Intensity matching

Bilateral Filter

Local contrast

Careful combination

Post-process

Result
Local Contrast: Detail Layer

• Uniform control:
  – Multiply all values in the detail layer

Input

Base + 3 \times \text{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

Input signal

High frequency H

Amplitude |H|

Edge-preserving filter

Textured region ➞ Large high-frequency

Smooth region ➞ Small high-frequency

Textured region ➞ High textureness

Smooth region ➞ Low textureness

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

Input

Textureness
Textureness Transfer

Step 1:
Histogram transfer

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

Input textureness → Model textureness → Desired textureness

Input detail → Output detail
Global contrast

Input Image

Bilateral Filter

Intensity matching

Local contrast

Textureness matching

Careful combination

Post-process

Result
Global contrast

Intensity matching

Bilateral Filter

Input Image

Careful combination

Local contrast

Textureness matching

Result

Post-process
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**.

![Diagram showing initial result, remapped intensities, and corrected result.]
Effect of Detail Preservation

uncorrected result

corrected result
Global contrast

Input Image

Intensity matching

Bilateral Filter

Local contrast

Textureness matching

Constrained Poisson

Post-Process

Result
Global contrast

Input Image

Intensity matching

Bilateral Filter

Texturenness matching

Local contrast

Constrained Poisson

Post-Process

Result
Additional Effects

- **Soft focus** (high frequency manipulation)
- **Film grain** (texture synthesis [Heeger 95])
- **Color toning** (chrominance = \( f(\text{luminance}) \))
Recap

Input Image

Global contrast

Intensity matching

Bilateral Filter

Local contrast

Textureness matching

Constrained Poisson

Soft focus

Toning

Grain

Result

slide by S. Bae, S. Paris and F. Durand
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]
Result

Model
Input

Result
Result

Model
Comparison with Naïve Histogram Matching

Input

Naïve Histogram Matching

Local contrast, sharpness unfaithful

Model

Snapshot, Alfred Stieglitz

Our result

Naïve Histogram Matching

Slide by S. Bae, S. Paris and F. Durand
Comparison with Naïve Histogram Matching

Input

Histogram Matching

Local contrast too low

Model: Clearing Winter Storm, Ansel Adams

Our Result
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
Style Transfer for Headshot Portraits [Shih 14]

- Make look like

Ordinary photo

Professional photo

- Transfer the style from the example photo
- Automatic
Problem statement

- **Input**: a casual frontal portrait and an example
- **Output**:
  - The input portrait rendered in the example style
  - Automatic
  - The style includes texture, tone, and color
Key idea #1: local transfer

- Local: eyes, nose, skin, etc. are treated differently
Key idea #2: multi-scale transfer

- Textures at different scales are treated differently.

Portrait #1

Portrait #2
Overview of the algorithm

1. Dense matching between the input and example
2. Multiscale transfer of local statistics
3. Post processing on eyes and background
Step 1: dense matching

- Rigid warp + SIFT flow to align semantic features [Liu et al. 2008]
Step 2: multi-scale local transfer

1. Construct Laplacian stacks for the input and the example

2. Local match at each scale

3. Collapse the matched stacks to create the output of this step
Laplacian using a face mask

- Preserve the hair boundary using normalized convolution and a face mask
Step 3: post-processing

- Adding eye highlights
- Replacing the background

Input  Example  Without eye highlights  Adding eye highlights (Our final result)
Results

Example

Output
Comparison

Input

Example

Global transfer
[Bae et al. 2006]

Our result

slide by YiChang Shih
Our method [Sunkavalli et al. 2010]

Histogram transfer [Reinhard et al. 2001] [Pitié et al. 2007]

Photoshop Match Color

slide by YiChang Shih
Limitations

- Require the input and the example to have similar facial attributes, e.g., skin color
- Cannot handle hard shadows on the input