Lecture 22

Images

* Course logo spider web photograph from Morguefile openstock photograph by Gabor Karpati, Hungary.
Back to Basics
Pixels
Recognition of Digital Images of the Human Face at Ultra Low Resolution Via Illumination Spaces

Jen-Mei Chang, Michael Kirby, Holger Kley, Chris Peterson, Bruce A. Draper, J. Ross Beveridge • ACCV • 2007

Abstract

Recent work has established that digital images of a human face, collected under various illumination conditions, contain discriminatory information that can be used in classification. In this paper we demonstrate that sufficient discriminatory information persists at ultra-low resolution to enable a computer to recognize specific human faces in settings beyond human capabilities. For instance, we utilized the Haar wavelet to modify a collection of images to emulate pictures from a 25-pixel camera. From these modified images, a low-resolution illumination space was constructed for each individual in the CMU-PIE database. Each illumination space was then interpreted as a point on a Grassmann manifold. Classification that exploited the geometry on this manifold yielded error-free classification rates for this data set. This suggests the general utility of a low-resolution illumination camera for set-based image recognition problems.

5 Figures and Tables
Colors (RGB)

- Visual range
  - red (700 nm) ...
  - to violet (400 nm)
- Ever wonder why?
  - Red, Green & Blue
- Physics?
  - Not really.
- Neural Biology?
  - Much Closer.
Tristimulus Theory of Color

- The tristimulus theory says cones in the human eye detect 3 primitive colors:
  - red, green, and blue.
- Energy near red excites response.
- Same for green and blue.
- All the rest of the "detail" goes away.
- RGB Displays therefore cheat.
- Might be why dogs don’t like TV ....
Why Don’t Dogs Watch TV?
The RGB Cube

- 3 Dimensions
- Move along:
  - Red
  - Green
  - Blue
- Direct tie to tristimulus theory.

Photo Editing Tools - GIMP
Editing Tools - Photoshop
Back to specifying colors

<table>
<thead>
<tr>
<th></th>
<th>Hex</th>
<th>Dec.</th>
<th>Binary</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
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<td>54</td>
<td>00110110</td>
</tr>
<tr>
<td>G</td>
<td>f1</td>
<td>241</td>
<td>11110001</td>
</tr>
<tr>
<td>B</td>
<td>36</td>
<td>54</td>
<td>00110110</td>
</tr>
</tbody>
</table>
GIF Image Format

- Graphics Interchange Format
- Limited to 256 colors
- Designed for flat graphics
  - Not for photographs!
  - Uses color map, more in a minute.
- Superseded by 8 bit PNG
  - But it certainly is universal ...
Examples for this Lecture

Here are some examples that go with lecture 23 on images.

- **Example 1**: Anti aliased text using transparency
- **Example 2**: Anti aliased text using alpha blending
- **Example 3**: Examples of transparency within an image
- **Example 4**: Examples of transparency with styling

Here is a file you may download with source for images and all pages show here: lec24.zip
Saving as Gif

- Color Table.
  - Entry 1
    - 000000
  - Entry 2
    - 006600
  - Entry 3
    - Transparent.

- Size
  - 56,300 bytes
  - To 771 bytes.
Anti-Aliasing is usually a good thing! (But beware).
Gif and Compression

- Part 1:
  - Color Table

- Part 2:
  - Run Length Encoding
  - Lempel-Ziv-Welch
  - Consider simple type
  - Note duplicates
  - Replace
  - Lossless!

```
1 1 1 1 1 1 1
1 2 2 2 2 1 1
1 1 2 2 2 1
1 1 1 1 1 1
```

```
1111111122211111
222111111111
(7,1),(3,2),(4,1),
(3,2),(7,1)
7132413271
```
**GIF Animations**

- GIF allows multiple frames in one file.
- Browsers sequence through frames.
- Result is a simple form of animation.
- Leads us to Deidre LaCarte’s famous*

...  

- Now http://www.hamsterdance.org/hamsterdance/

Thanks to Wikipedia for providing an excellent history of hamster dance.
JPEG Image Format

- Joint Photographic Export Group.
- Full 24 bit color.
- But, Some information is lost.
- This is why one specifies quality level.
- Essence - Discrete Cosine Transform
  - Wikipedia (again), very nice synopsis.
Quality Level Examples

116KB  136KB  324KB

Morguefile image by Nanette Bartet.
JPEG and Plain Text, Note a Good Combination.

This is your text before jpeg

This is your text after jpeg

Notice artifacts in the white background!
PNG Image Format

- Portable Network Graphics
- Comes in two flavors
  - 8 bit color mapped, replaces GIF.
  - 24 bit full color, replaces JPEG.
- Includes an alpha channel
  - Practical transparency.
Alpha Channel Review.

- A good way to use the last byte :-) 
- Consider a 32 bit word ...

<table>
<thead>
<tr>
<th>Alpha</th>
<th>Red</th>
<th>Green</th>
<th>Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000000000001101101111000100110110</td>
<td>80 36 F1 36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Alpha controls blending
  - Alpha = 0 (000) - transparent.
  - Alpha = 1 (255) - completely covers.
  - Alpha = 0.5 (128) - 50/50 blend.
Modern Operating Systems Support Transparency.

- For example, you are reading this through a unix terminal under OS X using the aqua graphics capabilities.
Anti Aliasing Revisited

Here is the GIF image of text with anti-aliasing and transparency.

... and another background.

Recall from lecture 7 how anti-aliasing is source of "halo" effect described in the text.

Now here is essentially the same example, but using a 24 bit PNG image created in Photoshop with anti-aliasing using the alpha channel to gradually blend the text color into whatever background is beneath it.
Semitransparent - image

The top image uses the alpha channel to specify opacity.

Photoshop Opacity is 75%
Semitransparent Images

Examples of Image Transparency (and Placement)
In this example the top image was created with an alpha value of 0.75.

Examples of Image Transparency (and Placement)
In this example both images are solid - not transparency. Transparency is determined by css 'opacity' attribute.