How to Program with Images

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What is an image?

• Images are fields of colored dots
• Each dot is called a pixel = picture cell
• Standard test image with detail, shading, texture, sharp & blurry regions:

  Lena Soderberg
  (controversy!)
Color Models

• Images can be gray scale, color, or color with an alpha (transparency) channel

• Most common color representation is RGB (Red, Green, Blue). This is the representation used to put pixels on the screen

• Other models include CMYK (used for print) and YUV (often used for input from cameras, compression, and transmission)
What is an image? (2)

- Images are 2 dimensional arrays of data, with an associated width, height, and color depth.
- Images typically use one byte per color channel per pixel.
- Gray images have 1 color channel. RGB images have 3 color channels. RGBA images have 4 color channels.
How do I get at the data?

• Some image handling APIs have nice interfaces, but speed can be a problem.

• You will probably have to handle the bytes of data directly at some point
How do I get at the data?

- $X$ = desired row
- $Y$ = desired column
- $C$ = color channel (red, green, blue, …).
- $Bpp$ = Bytes per pixel (color channels)
- Image data is normally stored in row major order
- Note that there may be multiple values associated with each $x,y$ pixel
- $\text{Data}(x,y,c) = y \times (width \times Bpp) + x \times Bpp + c$
Color to Gray Scale Conversion

• Many computer vision and image processing algorithms are defined for gray scale images

• Converting from color to gray scale is a very common operation
Color Conversion

- Quick and dirty conversion: Grab the Green Channel
- Average R, G, B: \((R+G+B)/3\)
- Max(R, G, B)
- Weigh them: \(0.3*R + 0.6*G + 0.1*B\)
Tools of the Trade

- OpenCV is a widely used, open source computer vision library maintained by Intel
- Provides libraries for image I/O, movie I/O and camera capture
- Industrial strength computer vision and image processing implementations
- Quick and dirty GUI toolkit
Tools of the Trade

• Irfanview is a freely available image viewer and possibly one of the most useful programs ever.
Common Gotcha’s

• Sometimes the mapping from a weird looking image to the actual error is not obvious
Common Gotcha’s Color Order

• RGB vs. BGR
Common Gotcha’s
Wrong Width

• Incorrect width can result in an image with strong diagonal structure

Actual width: 512

This image width: 508
Common Gotcha’s
Wrong Color Depth

- Mismatched color depth can result in an image with a rainbow effect
Common Gotcha’s
Windows line endings

• On Windows, it is critically important to open image files in binary mode.
• Otherwise, Windows helpfully strips out any bytes with value ‘\r’ (20).
Image File Formats

- PPM / PGM is the simplest file format ever, but not supported by Photoshop or MS Image Viewer. Uncompressed.
- BMP: Microsoft’s uncompressed image format
- GIF: Images are compressed using run-length encoding, and reducing the number of colors used. Licensed, not open
- JPEG: Images are compressed by throwing away high frequency information
Go to the CS 585 Lab tomorrow for hands on experience with images!