Motivation

- Handling image data is the most basic task in computer vision and image processing
- Images are everywhere! Sources include files, live cameras, and movies
What is an image?

- Images are fields of colored dots
- Each dot in a picture is called a pixel (picture element)
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), HSV (used by graphic artists)
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 need to learn how to compute indexes into images and handle the raw data.
How do I get at the data?

- $X =$ desired row
- $Y =$ desired column
- $C =$ color channel (red, green, blue, …).
- Channels = Bytes per pixel (color channels)
- Image data is normally stored in row major order
- $\text{Data}(x,y,c) = y*(width*\text{Channels}) + x*\text{Channels} + c$

![Diagram of image data storage](image.png)
Color 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

- Human studies have given us human sensitivities to the various colors.
Tools of the Trade

- OpenCV is a widely used, open source computer vision library
- 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: 960

This image width: 958
Common Gotcha’s
Transposed Width/Height
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

- PNG: **Use this.** Non-lossy compression, widely supported.
- JPG: **Don’t use this** (for Computer Vision). Images are compressed by throwing away high frequency information.
- 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
Now, you’re ready!