Histograms, Color Channels, and some Editing Techniques using GIMP
Histograms

• A histogram is a vertical bar graph with no spaces between the bar *positions*.

• Using raw values, you might have some bars whose true height exceeds the height of the display window, so you might scale the histogram in some way so that the full height of the histogram’s space is utilized by the bar with the largest value.
  
  – Scaling can be linear, in which case the largest value is used to mean “100% height” and the height of the other bars is based on the ratio of their value to that largest value.
  
  – It can also be logarithmic, in which case a log is selected that will allow the log largest value to mean “100% height” and the height of the other bars is based on taking that log of their values too.
Histograms: Lunar Example

Linear Scaling

Logarithmic Scaling
Histograms: Snow Example

Linear Scaling

Logarithmic Scaling
Building a Histogram about an Image

• To build a histogram displaying information about an image, we need to look at each pixel or the image, and “count” something.

• For luminance, we can count how many pixels there are with each possible luminance level.
  – In a typical 24-bit RGB image, we can think of there as being 256 possible luminance levels (0=black, 255=white).

• We can then create a drawing surface that is 256 pixels wide, and draw 256 vertical lines representing each of the possible levels of brightness.

• We will explore this in code on Thursday, but we can play with it in an app now…
Interpreting the Histogram

• Interpreting an image’s histogram is not a straight-forward task.

• It is often said that it is desirable to have:
  – Brightness values spread across four or five of the regions of the spectrum to provide good overall brightness.
  – Some good steepness on some of the curves displayed within the histogram to provide good contrast.
  – No pixels at absolute black or absolute white, so that you know nothing has been lost in darkness or blown out in light.

• However, there are cases where you want to have some extremes, or smoother curves, etc.
Adjusting Based on Histogram

If there are “blank” bars at the left or right of the histogram, you can adjust the image without discarding information by “stretching” the available information across the entire range.

– Doing this on the side representing high luminance (typically the right hand side) will lead to a generally brighter image. The brightness of each pixel is potentially being shifted towards a higher value.
– Doing this on the side representing low luminance will lead to a generally dark image. The brightness of each pixel is potentially being shifted to a lower value.
– Doing both at the same time will tend to make the bright things brighter and the dark things darker.

There is also a gamma/midtones slider in the middle that you can use to adjust emphasis between shadows and highlights.
Adjusting Based on Histogram

You can also adjust the shape of the color curve to pull out contrast in different ways.
Using an S-Curve
Exploring in GIMP…

In class on Thursday, I’ll post the moon, snow, and ballroom images and you’ll explore them live on your classroom computer.
Visual C#

• The program we will be exploring generates a histogram for each RGB color channel, and for overall brightness.
• It also allows us to save scaled-down versions any of those four views.

• Try viewing a variety of images within the program.

• We can experiment with different ways to use red, green, and blue to generate the brightness value for a pixel.
  – Take the average of all three values.
  – Take the average of the minimum and maximum values.
  – Try to make your own formula…
Photosites and Filters

• To get the “most” out of a sensor, you could have a sensor with unfiltered photosites that capture brightness levels.

• You would then capture a series of images with a different colored filter over the entire sensor.

• Finally, you would combine these individual color channel images to create a full-color image.

• NASA does this!
Actual NASA Image Files
Gray to Color

Let’s explore merging these three grayscale images into a single color image in GIMP...
Making a Grayscale image Redscape

Load the “red” filter grayscale image (601nm in this case).

Add a new blank layer (Layer – New Layer).

Set the foreground color of the paint tools to RED.

Use the paint bucket to fill in the new layer as all red.

Set the layer mode to Multiply.

Save this as a new file with a name like red.jpg
Repeat…

Now, do the same for the “green” and “blue” filter grayscale images.
Combining Color Channels

• Create a blank document the size of the images.
• Make sure that the Layers dialog is open. If it isn’t go to File menu in the main window, move the mouse down to the Dialogs option, and from the list that comes up, select Layers.
• For each of the three images, go to the File menu in the image’s window and select Open as Layer and then open the image file containing the individual channel.
  – In the Layers dialog, click on the RED layer and confirm that the mode is Normal.
  – In the Layers dialog, for both the GREEN and BLUE layers, click on the layer and set the mode to Difference.
    Note: For non-pure color filters, use Screen instead of Difference.
My own filters in front of lens...
Explore Layer Modes in GIMP

- There are a variety of ways in which layers can be combined.

- One thing that you might try is:
  - Load the GRAY channel image.
  - Move it to be between the white background layer and the RED channel layer.
  - Set the GRAY channel’s mode to Normal.
  - Set the other three channels’ modes to Difference.

- Explore other modes...
Adjusting Levels in PART of an image

• There are times when you do not want to adjust an entire image’s levels. There might be excellent detail in places, while some portions are too light or too dark. Adjusting the entire image’s levels could obscure or blow out the details that were originally fine.

• We can select part of the image, and then adjust levels solely on that part.
  – Want to select the correct region(s). These region(s) might be non-contiguous.
  – Want to have smooth transitions between the sections being adjusted and those remaining untouched.
Color Range Selection and Feathering

- Many tools such as Photoshop and GIMP allow you to select portions of an image based on a range of colors. In GIMP you can follow these steps:
  - Go to the Select menu on the image window and then to By Color. In the main GIMP window, the lower segment should have options labeled as being for Select By Color.
    - **Mode**: I typically set the mode to be Replace the current selection, but the others are sometimes useful as well.
    - **Anti-aliasing**: You probably want to check this so that diagonals are smoothed.
    - **Feather edges**: This refers to the edges of the selected regions. Feathering allows for gradual transitions of the adjustments around the edges for smoother borders between adjusted and unadjusted. You’ll probably want to use this, with a radius of somewhere around 8 pixels.
    - **Threshold**: If you want to select colors with similar values rather than just one exact color, you set this to allow colors within a certain distance to be selected. For levels adjustments, I tend to set this to around 100 as a starting point.
  - Click on a part of the image that represents the area you would like to adjust (ie: a dark place or a bright place). Part of the image will become selected.
Some resources:

GIMP downloads:

OS X:     http://gimp-app.sourceforge.net/

http://marsrovers.nasa.gov/mission/spacecraft_instrumentation/pancam.html
http://marsrovers.jpl.nasa.gov/gallery/all/spirit_p003.html