

## Lab 4: Image Enhancement: Intensity Transformation

*Due TBD*

### **Goals:**

- 1) To experiment with image restoration and intensity enhancement;
- 2) To gain experience manipulating remotely-sensed images of Mars.

### **Introduction:**

In this lab, you will be working with images taken by the Mars Science Laboratory (MSL) mission (<http://mars.nasa.gov/msl/>). The images you have are from the navigation and hazard cameras on board the *Curiosity* rover that is now exploring Gale Crater on Mars ([https://en.wikipedia.org/wiki/Mars\\_Science\\_Laboratory](https://en.wikipedia.org/wiki/Mars_Science_Laboratory)). You can view and download all the raw images from these cameras and others at <http://mars.nasa.gov/msl/multimedia/raw/>.

### ***Intensity Transformations***

Image pre-processing and high-level image interpretation both require intensity transformations (contrast stretches). Often these are applied to the results of other manipulations – e.g., filters, etc. – to make the result more interpretable. Essentially the goal is to bring out spatial detail by selectively altering the contrast ratio of the image. Both ENVI and MATLAB have many functions to implement both linear and non-linear contrast stretches. See the online help, the course notes, and the readings for details.

### **Instructions:**

There are three, dark, low-contrast images (in .JPEG format) on \\yowa. These are various surface photos taken by *Curiosity*. They were obtained from:

- [http://mars.nasa.gov/msl/multimedia/raw/?rawid=NLB\\_509714907EDR\\_F0530186NCAM00293M\\_&s=1264](http://mars.nasa.gov/msl/multimedia/raw/?rawid=NLB_509714907EDR_F0530186NCAM00293M_&s=1264)
- [http://mars.nasa.gov/msl/multimedia/raw/?rawid=FLB\\_509893847EDR\\_F0530186FHAZ00206M\\_&s=1266](http://mars.nasa.gov/msl/multimedia/raw/?rawid=FLB_509893847EDR_F0530186FHAZ00206M_&s=1266)
- [http://mars.nasa.gov/msl/multimedia/raw/?rawid=FRB\\_508741893EDR\\_F0522388FHAZ00206M\\_&s=1253](http://mars.nasa.gov/msl/multimedia/raw/?rawid=FRB_508741893EDR_F0522388FHAZ00206M_&s=1253)

Write a MATLAB program to do the following:

- 1) Load an image and display it (you can use Image Processing Toolbox (IPT) functions if you like).
- 2) Extract image statistics (mean and standard deviation) from and plot image histograms for the *original* image (use MATLAB's built-in functions and/or your own functions from previous labs).
- 3) Using IPT or (*for extra credit*) your own functions, perform intensity transformations (contrast stretches) to:
  - a. Enhance the darkest parts of the image;
  - b. Enhance the lightest parts of the image;
  - c. Perform histogram equalization.

- 4) Extract statistics (mean and standard deviation) from and plot image histograms for each of your three *enhanced* images.
- 5) Save the three enhanced images to new files (you can use IPT functions here).

The MATLAB manuals, online help, and the reading (`chapter_03_dipum.pdf`) describe some of the IPT functions for doing intensity transformations and histogram operations. Your code should be generic (and customizable) enough to work with any of the provided images (with different parameters, of course), as well as any other image. Try using the `input` command (and similar ones) to ask the user for input so that you can interactively change the arguments of the enhancement and other functions you use in your code. You are free to use whichever methods you feel best enhance the image(s). However, be sure to comment your code so that I know what you are doing! See the hint program listing attached to this lab for some inspiration.

**What to Turn In and How:**

MATLAB code (`.m` files only) for manipulating the contrast of your Mars rover images. Also include a *short* (2-page *maximum* plus figures, PDF format only) report of what your contrast enhancement did to your image(s). What did you do and why? What can you see in the enhanced image(s) that wasn't visible before? Anything cool? This is Mars after all! Be sure to put your name, date, etc. in a comment at the top of all your `.m` files. Also be sure to adequately comment your code so that I know what your programs do and how they work. Turn in your files via the `//yowa` dropbox.

Program listing for lab6\_part1\_hints.m:

```
% Opening Files

%from first handout from the first week's lab

theimage = imread( 'filename' ) %IPT function that recognized JPEGs

%you can use imread for other formats (e.g. TIFF, etc.)

% Plotting

%this was in the first handout from the first week's lab

figure( 1 )
imshow( theimage ) % IPT function to display image in a figure window

%use title, xlabel, ylabel, etc., etc. to make the figure pretty
%and apply a colormap if you want

% Statistics

%you should already know how to do this
%look at pg. 76-81 in PDF reading for histogram stuff
%make histogram plots using each of the methods in figure 3.7

% Intensity Transformations

%use the transformations discussed on pages 66-70 in the PDF reading
%this basically includes the power law (gamma, including linear)
%and the log functions.
%experiment with the arguments to these functions in order to enhance
%the different parts of the image

% Saving Files

%from first handout from the first week's lab

imwrite( theimage , 'output_image.tif' ) %IPT function to save to TIFF

%you can use imwrite for other formats (e.g. JPEG, etc.)
```