CS663, Assignment 2
Instructor: Prof. Suyash Awate
Question 1: Image Sharpening

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Problem Statement

(15 points) Image Sharpening.
Input images: (1) 1/data/superMoonCrop.mat, and (2) 1/data/lionCrop.mat. Assume the pixel dimensions to be equal along both axes, i.e., assume an aspect ratio of 1:1 for the axes.
Write code for image sharpening using unsharp masking and apply it to both the input images. To compare the original and filtered images, linearly contrast-stretch them to the same intensity range, say, [0, 1].
Tune the parameters (Gaussian standard-deviation parameter and the scaling parameter) to your best judgment, but such that the sharpening in the image is clearly visible. You may use the following Matlab functions: fspecial() and imfilter().

1. Write a function myUnsharpMasking.m to implement this.
2. For each image, show the original and sharpened versions side by side, using the same (gray) colormap.
3. Report the tuned parameter values for each image.

Code

(i) Code for Unsharp Masking

```
function [outputImage] = myUnsharpMasking(inputImage, W, sig, lap_scale)
        inputImage = double(inputImage);

        h = fspecial('log', [W W], sig);
        LoG = imfilter(inputImage, h);
        outputImage = inputImage + lap_scale .* (inputImage - LoG);
end
```

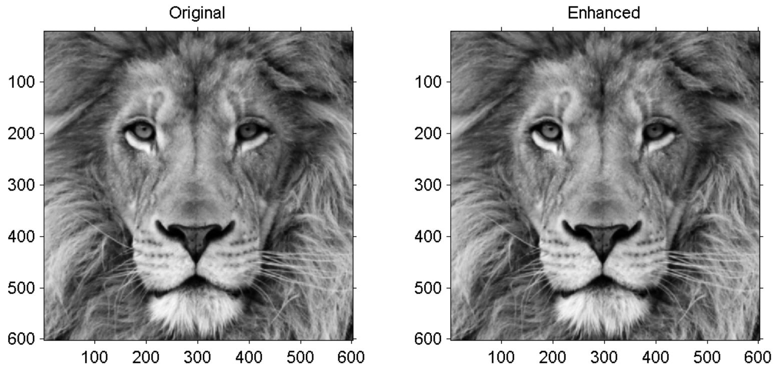
(ii) Main Script

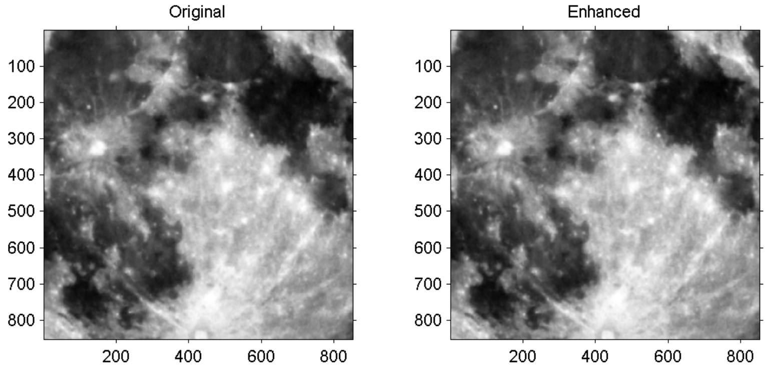
```
%% MyMainScript

tic;
%% Your code here
lion_struct = load('../data/lionCrop');
lion = lion_struct.imageOrig;
enhanced_lion = myUnsharpMasking(lion, 9, 0.6, 3.1);
plotAndSave(lion, enhanced_lion, 'lion_enhanced', 1);

moon_struct = load('../data/superMoonCrop');
moon = moon_struct.imageOrig;
enhanced_moon = myUnsharpMasking(moon, 9, 0.5, 8);
```

```
plotAndSave(moon, enhanced_moon, 'moon_enhanced', 2);
toc;
```

Implementation Details

This discussion was done in co-operation with Ravi Chandra. We made a tweak to come up with the refined image for this part. We observed that the range of intensities were occupying almost the entire domain from [0, 1]. This did not help much with the visual enhancement of sharpness. To work around this, we consider the points between 1 and 99 percentile of the intensity range and just consider them for displaying the final image. This leads to a much appreciated visual enhancement while staying correct with respect to the algorithm. We also add images for the case without this optimization. The code for this can be found out in the file 'MyNewLinearContrastStreching.m'.
We also have the images enhanced without using the above mentioned tweaking to the image, we don't get a lot of enhancement as shown:





The results shown in later section work on images stretched by the method as discussed above.

Optimal Parameters

We worked with a **window size of 9 X 9** for both the images. The parameters were tuned by trial and error i.e. by looking at the parameters which gave the sharpest image as possible (determined by visual inspection)

1. **Tuned parameters for the 'croppedLion' image:**
   Gaussian standard deviation parameter, $\sigma = \mathbf{0.6}$
   Weighting factor of the enhancement = **3.1**
2. **Tuned parameters for the 'superMoonCrop' image:**
   Gaussian standard deviation parameter, $\sigma = \mathbf{0.5}$
   Weighting factor of the enhancement = **8**

Result Images