22437 - Industrial Vision
Lab 4: Image Enhancement (Point Processing and Thresholding)

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Point Processing

Useful functions: *imcomplement*

Spatial domain operations are defined as:

$$g(x, y) = T[f(x, y)]$$

where $f(x, y)$ is the input image, $g(x, y)$ is the output image and T is an operator defined in some neighborhood of (x, y) around the input image. The simplest spatial domain operations occur when the neighborhood is the pixel itself, performing then a *point processing* operation.

Negative transformations

Negative images are useful for enhancing white or gray details embedded in large, predominantly dark regions of an image. Given an image with L intensity levels, its negative is obtained using the following expression:

$$g(x, y) = (L - 1) - f(x, y)$$

Perform the following tasks:

1. Open the image *breast.tif* and convert it to the range of values $[0.0, 1.0]$.
2. Obtain the negative of this image using the provided function in Matlab.
3. Display in a figure both images and their corresponding histograms.
4. What can be observed? What is the effect of applying the negative transformation to the image?

Log transformations

The general form of the log transformation is:

$$g(x, y) = c \times \log(1 + f(x, y))$$

where c is a constant. The log transformation maps a range of low input intensities into a wider range of high output values.

Perform the following tasks:

1. Write a function in Matlab to transform a grayscale image using the logarithmic transformation. The function signature should be:

   ```
   function logimage = logtrans(image, c)
   ```

   where *image* is a grayscale input image with values in the range $[0.0, 1.0]$, c is the constant and *logimage* is the output image.

2. Open the image *light.tif* and convert it to $[0.0, 1.0]$.

3. Apply the *logtrans* function to this image.

4. Display in the same figure both images and their corresponding histograms.

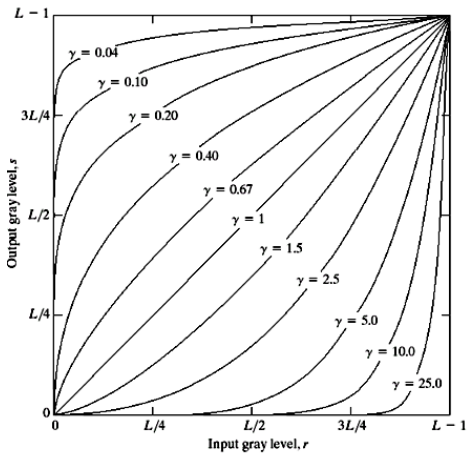
5. What can be observed? What is the effect of applying the log transformation to the image?

Power Law transformations

Power law transformations have the following form:

$$g(x, y) = c \times f(x, y)^{\gamma}$$

where c is a constant, usually established to 1, and γ is the exponent of the function. This transformation maps a narrow range of dark input values into a wider range of white output values or vice versa. Varying γ gives us a whole family of curves:



Perform the following tasks:

1. Write a function in Matlab to transform a grayscale image using a power law transformation. The function signature should be:

   ```
   function plimage = powerlaw(image, gamma)
   ```

   where *image* is an intensity image with values in the range [0.0, 1.0], *gamma* is the exponent of the power law transformation and *plimage* is the output image. Assume that the constant c is 1.

2. Display the image *spine.jpg* and its histogram.

3. If a lighter image is wanted, which values of γ do we need to use: lower or higher than 1?

4. Using different values of γ, obtain three lighter versions of the image. Show the resulting images and their corresponding histograms.

5. Which image would you use for a further processing step? Why?

6. Display the image *landscape.jpg* and its histogram.

7. Enhance the image using three power law transformations.

8. Show the resulting images and their corresponding histograms.

9. Which image would you use for a further processing step? Why?

Thresholding

Useful functions: *imbinarize, adaptthresh, graythresh*

Thresholding is the simplest method for image segmentation. From a grayscale image, it can be used to create binary images, which enable the development of more efficient computer vision algorithms and require less storage space. Thresholding, that can be also considered as a point operation, is defined as:

$$g(x,y) = \begin{cases} a & \text{if } f(x,y) > T \\ b & \text{if } f(x,y) \leq T \end{cases}$$

where usually a is white and b is black by convention, and T is an intensity threshold.

Perform the following tasks:

1. Open the image *screws.jpg* and display it.
2. In order to separate the screws from the background, what might be a good range of intensities for thresholding? Justify your answer graphically.
3. Write a function in Matlab to apply a thresholding operation to an image. The function signature should be:

   ```
   function binimage = thresh(image, T)
   ```

   where *image* is a grayscale image with values in the range $[0.0, 1.0]$, T is a threshold between 0 and 1 and *binimage* is the output binary image. *binimage* must be defined as type *logical*.
4. Binarize the image *screws.jpg* using the function written in the previous exercise and display the results.
5. Binarize the image *screws.jpg* using the appropriate Matlab function, display the results and compare them with the ones obtained in the previous exercise.
6. Analyze the Matlab function *adaptthresh* and *graythresh*. What does they do? Use *graythresh* for obtaining the value of the threshold with Otsu's method. Binarize *screws.jpg* with different thresholds and display the results.