Image Enhancement and Transforms

1. Given an input image **tire.tif** of arbitrary histogram, generate an output image that has a nearly uniform histogram by Histogram Equalization.

   (a) Compute the probability of occurrence of each of the 256 gray levels in the image and display the normalized histogram.

   $$P(r_i) = \frac{\text{Number of pixels of gray level } i}{\text{Total number of pixels}}, \ i = 0, 1, ..., 255$$

   (b) From the normalized histogram, compute the cumulative distribution function.

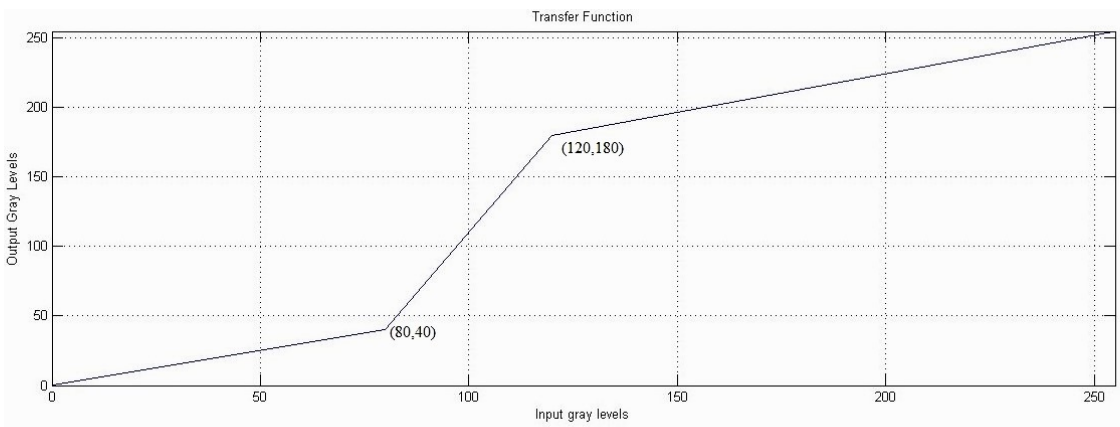
   $$T(i) = \sum_{k=0}^{i} P(r_k), \ i = 0, 1, ..., 255$$

   (c) Given a gray level r in the input image, map that level to

   $$y_r = \lfloor 255 \times T(r) \rfloor .$$

   (d) Display the histogram equalized image.

2. Perform contrast stretching on **cameraman.tif** image with the help of following transfer function as shown below :



3. Consider an input image **cameraman.tif** and add Salt and Pepper Noise using `imnoise` inbuilt function. Perform median filtering on the noisy image of varying mask size (3×3, 5×5, 7×7, and 9×9) and observe the filtering performance.

4. Consider an input image **coins.png**. Use an averaging filter of size 3×3 and 5×5 by convolving with the original image.

5. Use a Gaussian Low Pass Filter in frequency domain to remove Salt and Pepper Noise from the image **coins.png**.

6. Take two images **an.jpg** & **tu.jpg** from the folder *Face* and calculate their phase using FFT and exchange the phase between them. See the impact of phase exchange between two images.
   Hint:

   - $z = r\cos\phi + i\sin\phi$
   - $z = re^{i\phi}$

7. Implement the following two dimensional DFT equation on **moon.tif** image

$$F(k,l) = \sum_{m=0}^{M-1}\sum_{n=0}^{N-1} f(m,n)e^{-j\frac{2\pi}{M}mk}e^{-j\frac{2\pi}{N}nl}$$

   You can realize the same using `fft2` function of MATLAB.

8. Implement K-L Transform to find out Eigen faces and display them after transformation.

   Read the first 18 M×N face images contained in the folder named face and store them in a cell.
   Steps of KL Transform:

   (a) Raster scan each images to create 18 number of MN×1 vectors.
   (b) Transform each of the face vectors obtained from (a) to zero mean by subtracting the mean vector from each of them.
   (c) Stack the set of 18 zero mean face vectors from step (b) to form the rows of a matrix X. Matrix size: $18 \times MN$
   (d) Compute the 18 eigenvectors of XX^T.
   (e) Compute the eigenvector matrix of the covariance matrix R = X^TV.
   (f) Normalize each eigenvector of R to unit length. The normalized eigenvectors displayed as an image represent the Eigen Faces. Display the first 8 Eigen faces.

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