Please make a zip file named HW3_stdno_lastname and upload in cw. Feel free to contact me (aryansadeghi1374@gmail.com) if you have any questions.

Theoretical

1. $I(x, y)$ is an image and $N_i(x, y)$ is noisy versions of it $N_i(x, y) = I(x, y) + \eta_i(x, y)$ that all points (x, y) are uncorrelated and the noise is zero-mean.

   Prove that:

   a) $E\{\bar{N}(x, y)\} = I(x, y)$.

   b) $\sigma^2_{\bar{N}(x,y)} = \frac{1}{M} \sigma^2_{\eta(x,y)}$ Where $\sigma^2_{\bar{N}(x,y)}$ is variance of $\bar{N}(x, y)$ and $\sigma^2_{\eta(x,y)}$ is variance of η.

2. Find H(z) that Minimizes the MSE (mean square error). Is it Weiner filter or not why?
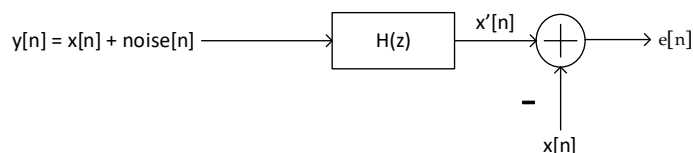
3. Show that v satisfies the condition $\text{Prob}[v \leq \mu] = \text{Prob}[u \leq F^{-1}(\mu)] = F(F^{-1}(\mu)) = \mu$.
   ($v = F_u(u) = \int_0^u p_u(u)du$ You can find more information about this equation in course slides Chapter 7 (ch_7_Enh.pdf) equation 7.11 in page 33.)

4. What is relation between unsharp masking and subtracting the Laplacian from an image. Discuss your answer.

5. What is principal component analysis? What are the advantage and disadvantage of using principal component?

Practical

If a question asks you to run the code on image(s), please save your results in a folder or leave them in Jupiter notebook file.

1. **Notch Filter**

   Restore the **Vessel.png** by implementing notch filter.

2. **Gaussian Smoothing Filtering**

   a. Apply a Gaussian smoothing filter with $\sigma = 5$ on the **Nature.jpg** file.

   b. Deblur the resulting image of previous part with the low-pass filtered inverse filtering approach.

3. **Denoising**

   a. Add white noise to **Airplane.jpg**

   b. Denoise the Noisy image of previous part.

   c. This time do part (a) and (b) with salt and pepper noise.

4. **Histogram matching**

   Write a function which takes an input image and a reference image and

   applies histogram Matching on the input image by matching the histogram with that of the

   reference image. Use **eye.png** and **eyeref.png** (converted to grayscale) as input and

   reference image respectively.