COL783 Assignment 2

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Q1.

Part a:

Original image

Disk kernel of r= 5. So size of kernel = 11 x 11 and convolved the image with mirror padding. M = 250, N =500

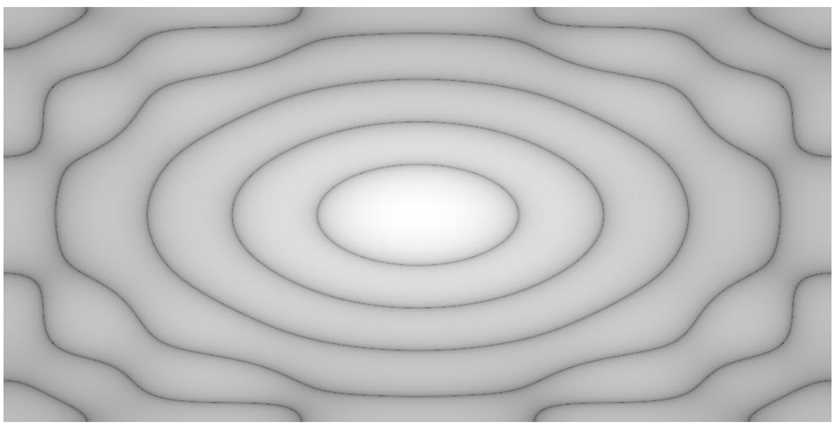
After convolving with disk filter:

Part b:

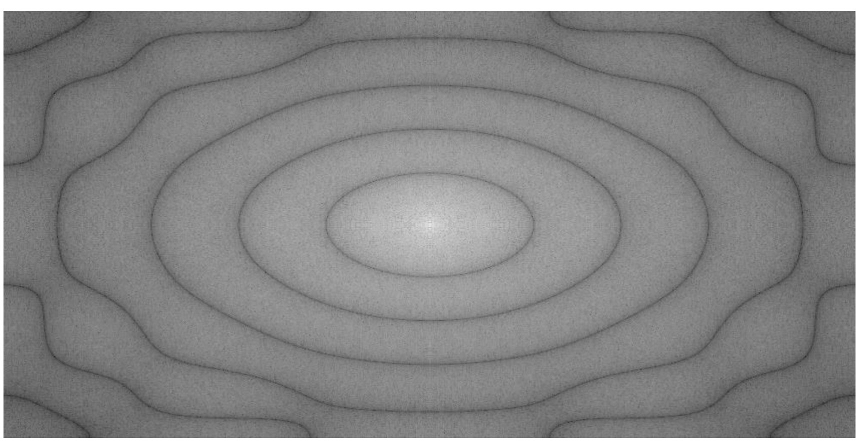
R = 5, kernel size = 11 X 11, M = 250, N =500

Mirror padding, padded image size 2M * 2N = 500 x 1000

Shifted kernel:

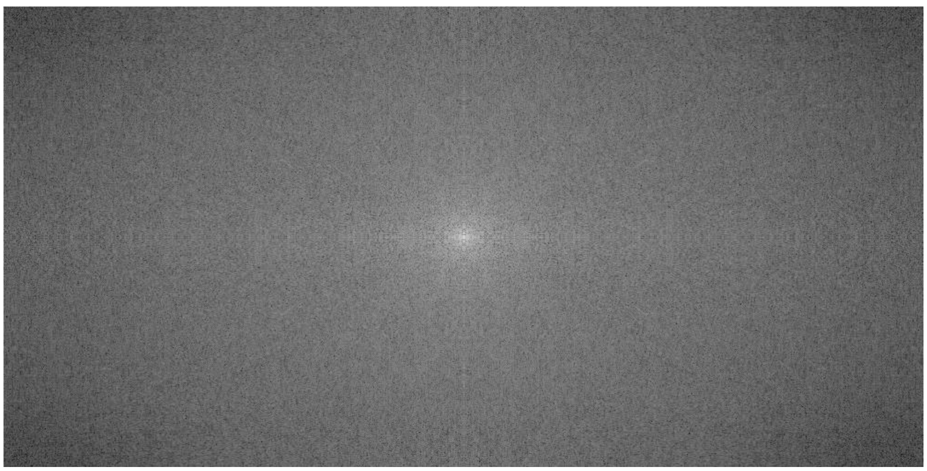


Filtered image in frequency domain:



Output of image filtered in frequency domain:

Shifted spectrum of original image:



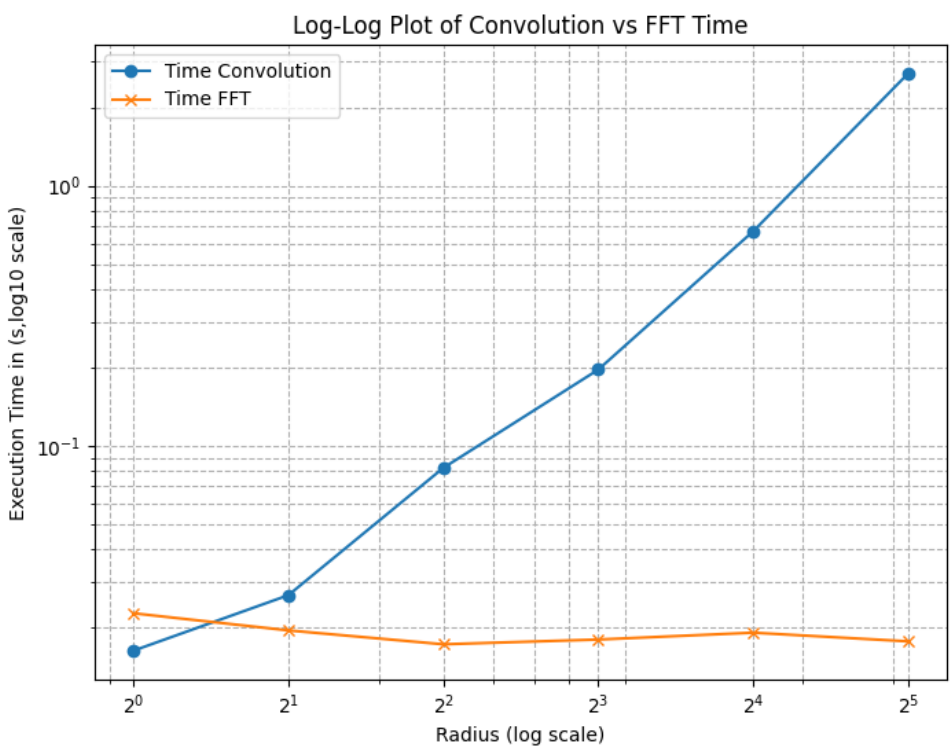
Part c:

The DFT of the blur kernel $h(x,y)$ appears elliptical, even though h is circularly symmetric, because it operates on a discrete grid with unequal image dimensions M and N.

When M != N (i.e., for a rectangular image), the frequency domain is sampled at different rates along the two axes. This causes the spatial frequencies to be scaled unevenly in the horizontal and vertical directions, distorting the circular symmetry of the spatial domain into an elliptical shape in the frequency domain. The elliptical appearance is a result of the Fourier transform applying different scaling along the axes due to the varying image dimension.

Part d:

Plot of execution time vs radius for FFT and convolution in log-log scale.



Q2:

Part a:

Original image: 500 x 400

Image after resampling using bilinear interpolation

Part b:

The cutoff frequency is given by nyqusit rate:

D0 of x = 1/ 2* Sx and D0 of y = 1/ 2*Sy where Sx, Sy are sampling rates along x and y axis.

Gaussian low pass filter is used for filtering the image.

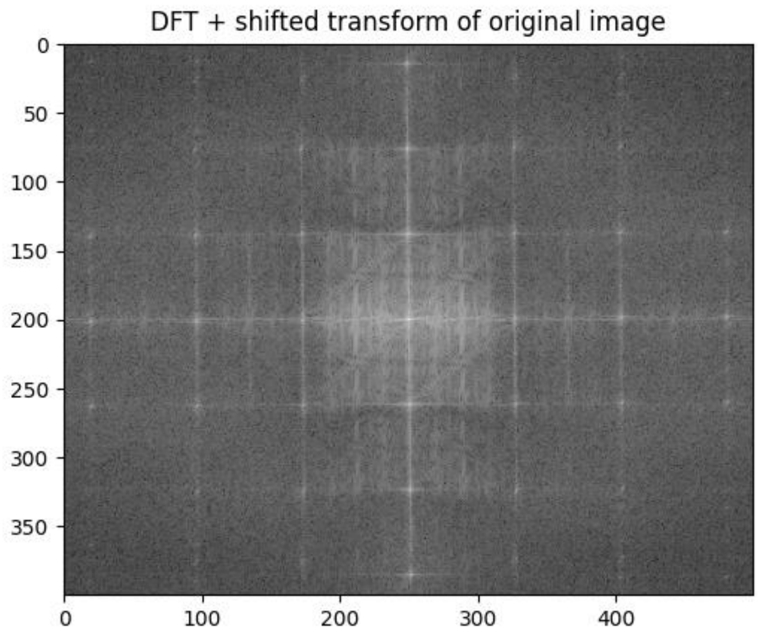
Sx =Sy = 0.2

Rescaled image without filtering the original image.

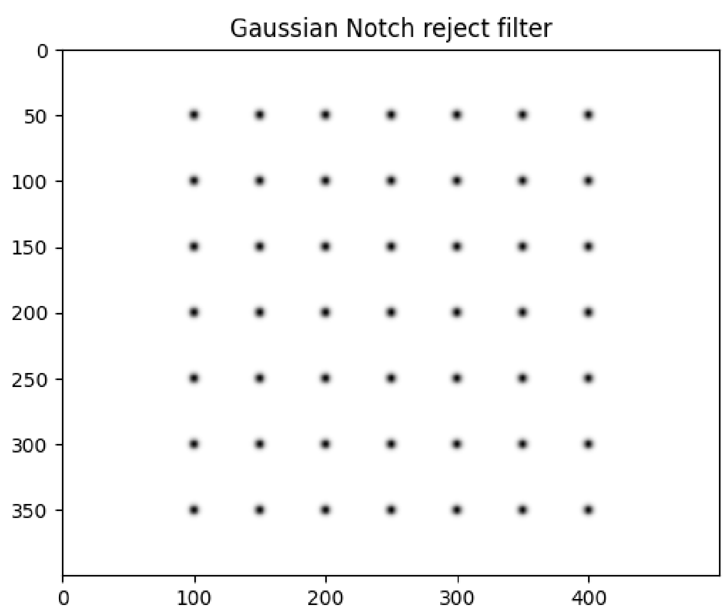
Rescaled image after filtering the original image.

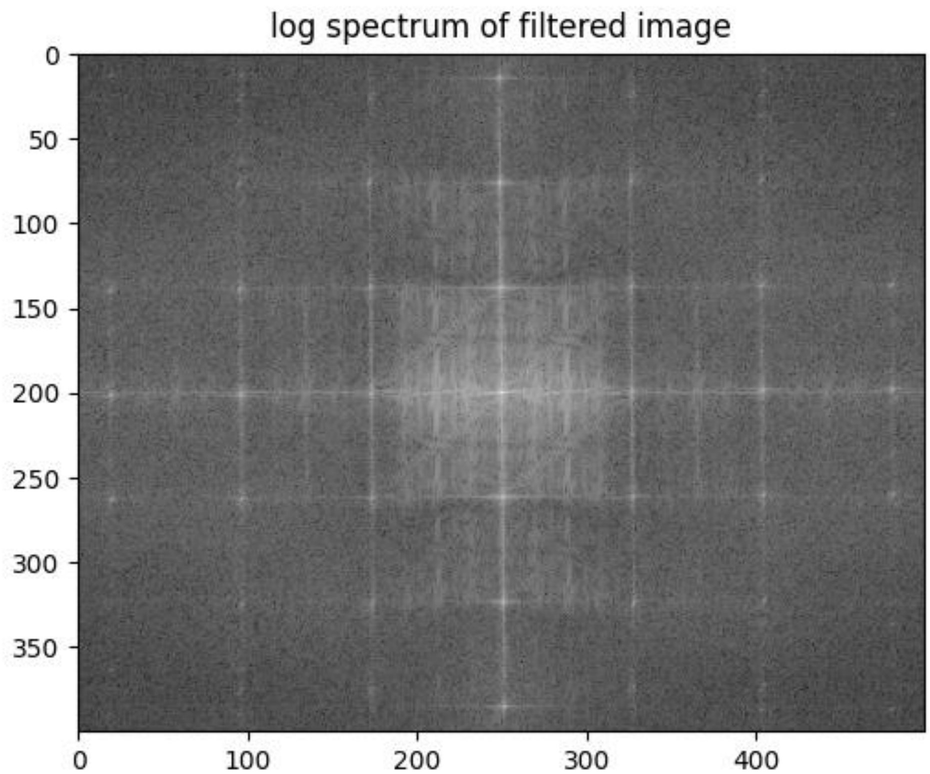
Part c:

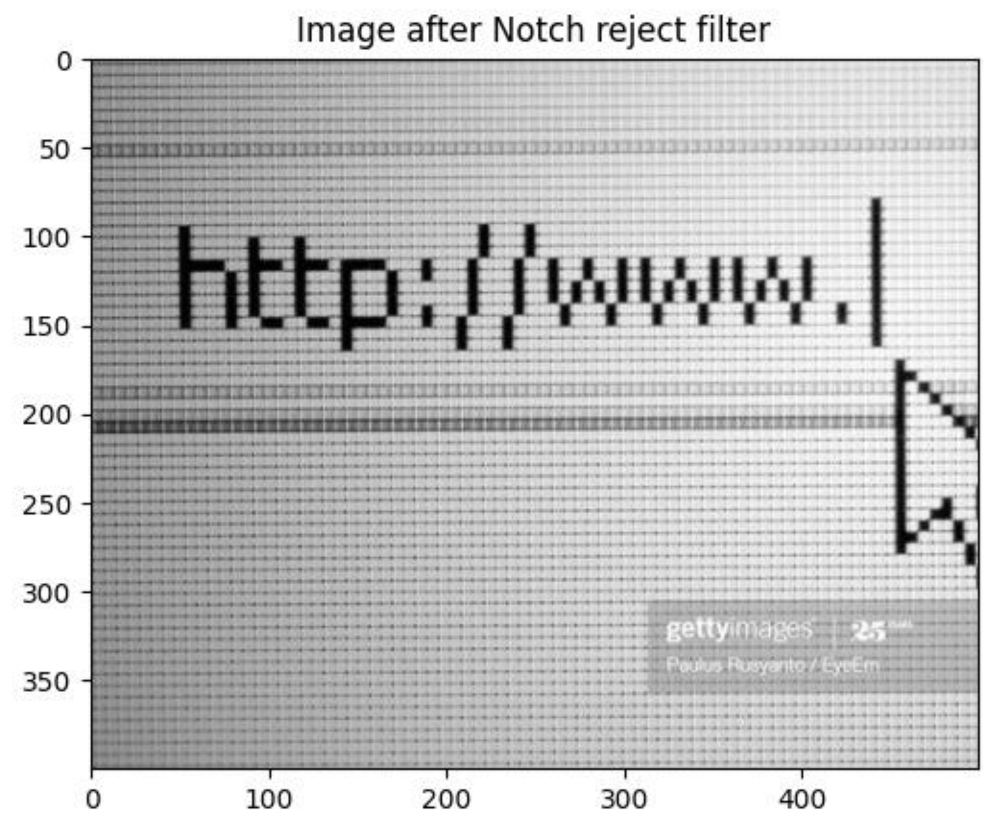
Original image:



D0 = 1/ 2*scale factor for notch reject filter




log spectrum of filtered image
0
50
100
150
200
250
300
350
0
100
200
300
400



Part d:

Algorithm for mean,variance,covariance of f in O(MN(m+n)) time:

Horizontal cumulative sum with window size m ,Cx:

Cx(i,j) =$\sum_{x=i-\frac{m}{2}}^{x=i+\frac{m}{2}} f(x,j)$ 0<=i < M

Time complexity = MNm

Vertical cumulative sum Cy with window size n:

Cy(i,j) = $\sum_{x=j-\frac{n}{2}}^{x=j+\frac{n}{2}} f(i,x)$ 0<=j< N

Time complexity = MNn

First do horizontal sum and then vertical sum on it.

Using Cx and Cy computing mean for f ,f**2 , f*g takes O(MN(m+n)) time

Using the relations:

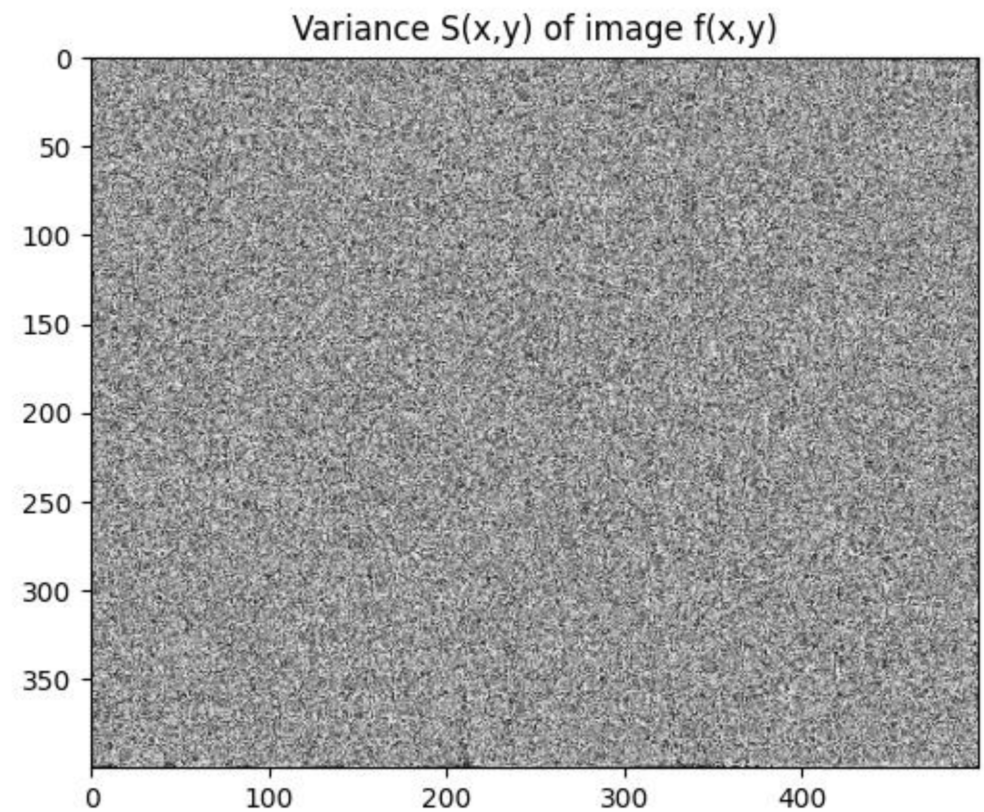
Var(X) = Mean(X^2) - Mean(X) ^2

*Cov(X,Y) = Mean(X,Y) - Mean(X)*Mean(Y)*

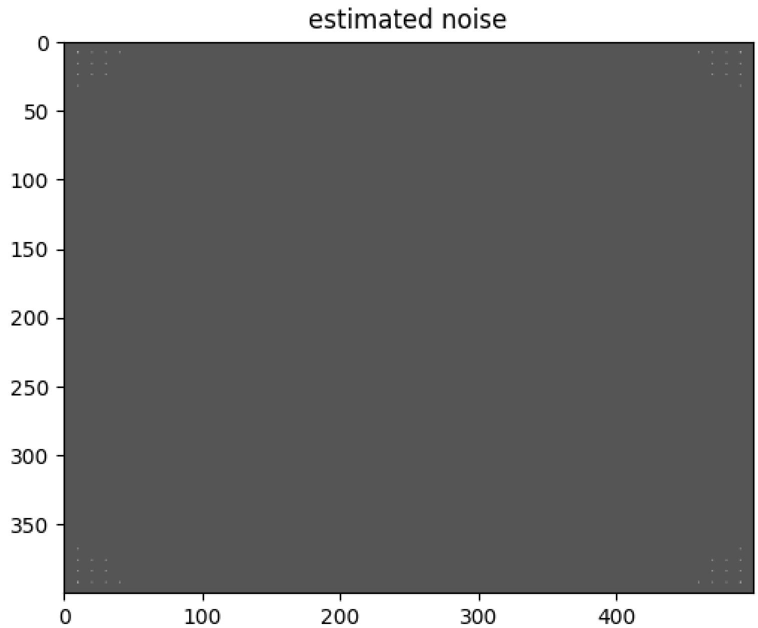
Var and Covariance takes O(MN) time , assuming mean is computed.

Overall time complexity = O(MN(m+n)) + O(MN)

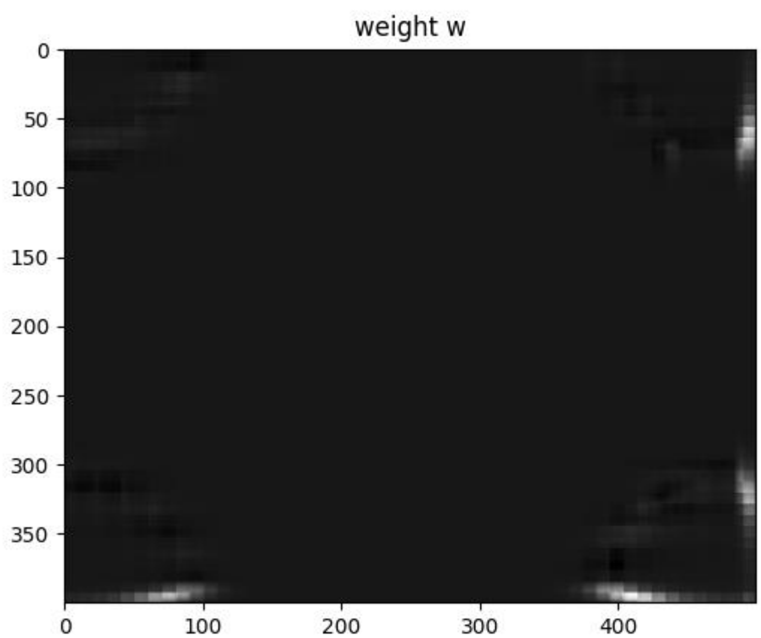
= O(MN(m+n))



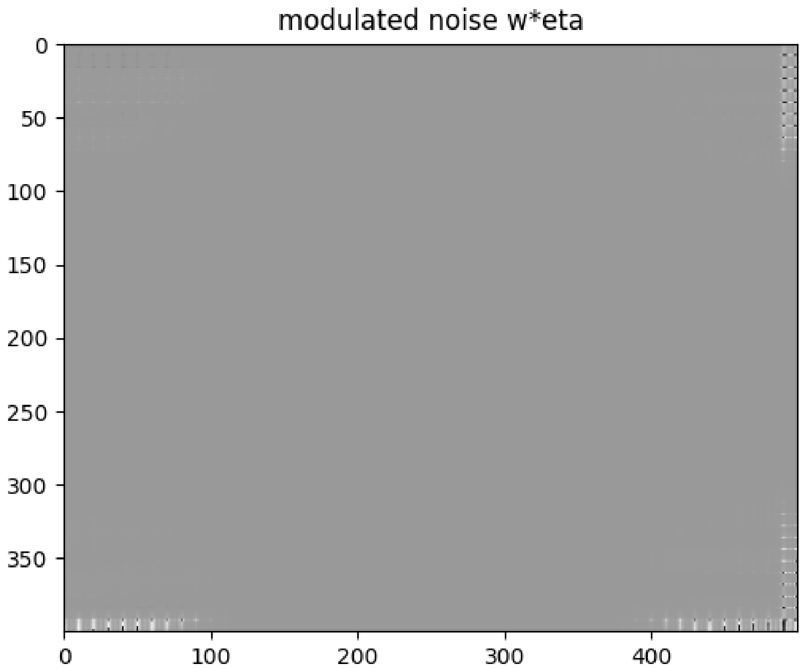
Part E:

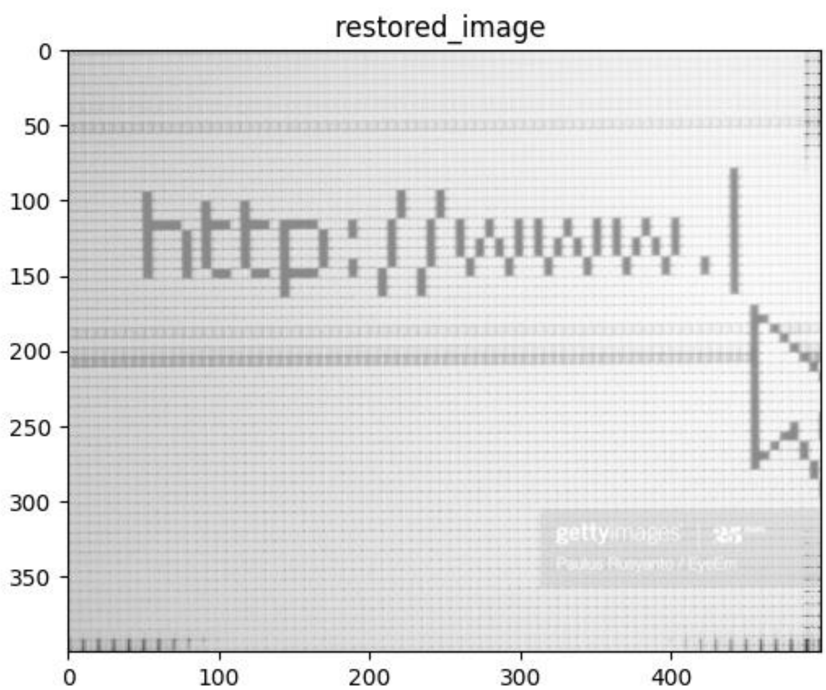


estimated noise
0
50
100
150
200
250
300
350
0
100
200
300
400



weight w
0
50
100
150
200
250
300
350
0
100
200
300
400


modulated noise w*eta
0
50
100
150
200
250
300
350
0
100
200
300
400


restored_image
http://www.
0
50
100
150
200
250
300
350
0
100
200
300
400