ES 331 Probability and Random Processes

Assignment 4

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Aim:

To restore a corrupt image by implementing a wiener filter.

Theory:

Wiener filter is used to remove blur caused due to linear motion or unfocussed optics.

Let
$f(x,y)$ be the uncorrupt image
$F(u,v)$ be the Fourier transform of the uncorrupt image
$h(x,y)$ be the point spread function
$H(u,v)$ be the Fourier transform of the point spread function
$n(x,y)$ be the additive noise
$N(u,v)$ be the Fourier transform of the noise
$g(x,y)$ be the corrupt image
$G(u,v)$ be the Fourier transform of the corrupt image

Then the following formula can be used for implementing the wiener filter.

$$W(u,v) = \frac{H^*(u,v)}{|H(u,v)|^2 + K(u,v)}$$

where, $K(u,v)$ is the ratio of PSD of noise and PSD of uncorrupt image

$$K(u,v) = \frac{|N(u,v)|^2}{|F(u,v)|^2}$$

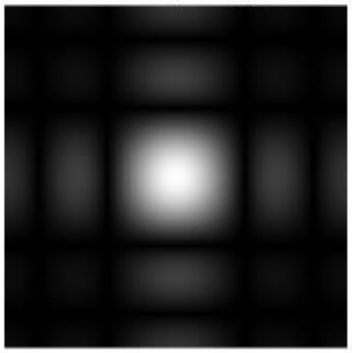
Procedure:

i) **Estimation of $K(u,v)$:**
   a. To estimate $K(u,v)$ 10 grayscale(512x512) images were used.
   b. A gaussian blur with standard deviation of 10 and kernel size of 5x5 was applied.
   c. A additive white gaussian noise of mean of 0 and variance of 0.01 was added to the blurred image.
   d. $N(u,v)$ and $F(u,v)$ were calculated for each image by using the inbuilt function in MATLAB(fft2()).
   e. $K(u,v)$ for each of the 10 images was calculated and the average stored for testing.

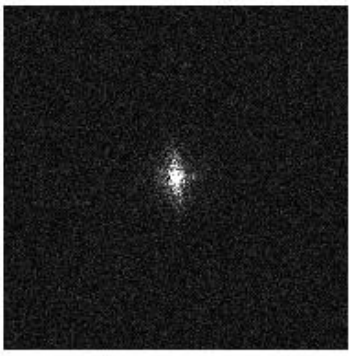
ii) Implementation of Wiener Filter:

a. 5 grayscale(512x512) images were used for testing.
b. A gaussian blur with standard deviation of 10 and kernel size of 5x5 was applied.
c. A additive white gaussian noise of mean of 0 and variance of 0.01 was added to the blurred image.
d. The Fourier transform of the corrupt image($G(u,v)$) and the point spread function were calculated($H(u,v)$)
e. $W(u,v)$ is found by the formula above for which the $K(u,v)$ used is the one estimated before.

Fourier Transform of point spread function



Fourier Transform of degraded image



Restored image

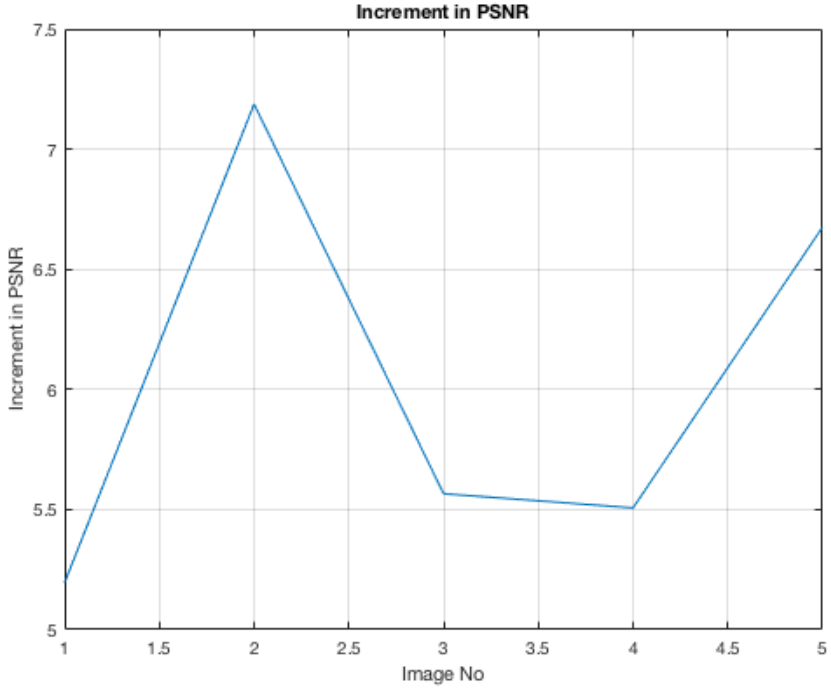
Orignal

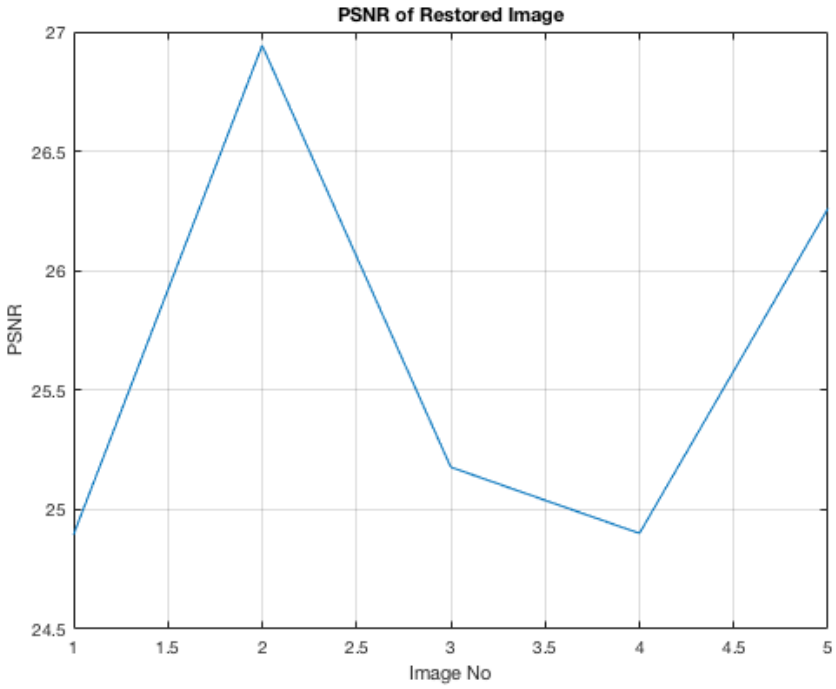
Noise+Blur

Blur

Results:

Image No	PSNR(Restored image)	PSNR(Corrupt image)	Increment in PSNR
1	24.895062	19.699579	5.195483
2	26.942488	19.755104	7.187383
3	25.177608	19.611743	5.565866
4	24.900558	19.393619	5.506938
5	26.260437	19.585012	6.675425





References:

- Intuitive Probability and Random Processes using MATLAB
- Dataset: Dataset of standard 512x512 grayscale images
- B14 Image Analysis, Andrew Zisserman, University of Oxford, Lecture 3
- MATLAB documentation https://in.mathworks.com