Jayakrishna Narra (jn1711, N19975518)

Sahil Paneri (sp4313, N10587481)

Assignment 1

Exercise 1

Filter H1

- Difference between original and filtered image in spatial domain:

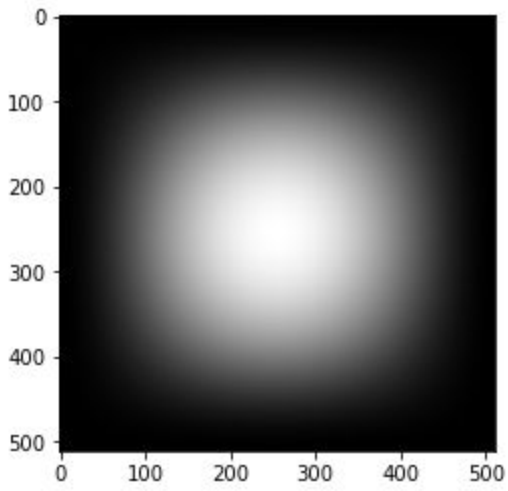
  The filtered image is a smoothed out version of the original image. This is because the filter used is a weighted average filter.

- Difference between original and filtered image in frequency domain:

  The high frequency components observed in the fourier transform of the original image are suppressed in the fourier transform of the filtered image. This is because the given filter is a low pass filter as evident from its frequency response.

- Correlation between filtering effect and frequency response

  The given filter is a low pass filter as observed in the figure:



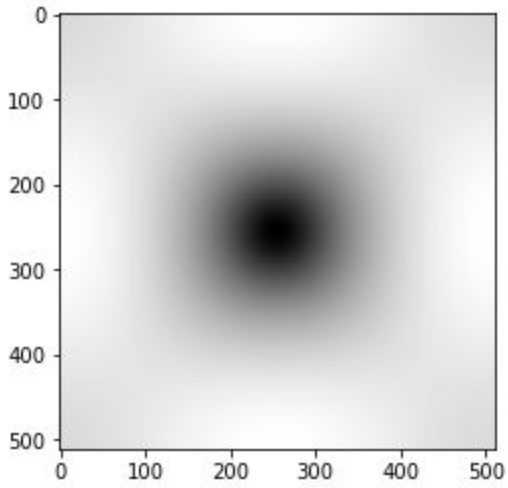
  Low pass filters remove the high frequency components of an image, thereby making it smooth. This phenomenon is clearly evident in the filtered image.

Filter H2

- We can clearly see that the edges are prominent in the filtered image and the contrast has become very low. This is because the filter used is a good filter for detecting edges, specially points.
- Difference between original and filtered image in frequency domain:

  The low frequency components observed in the fourier transform of the original image are suppressed in the fourier transform of the filtered image. This is because the given filter is a high pass filter as evident from its frequency response.
- Correlation between filtering effect and frequency response

  The given filter is a high pass filter as observed in the figure:



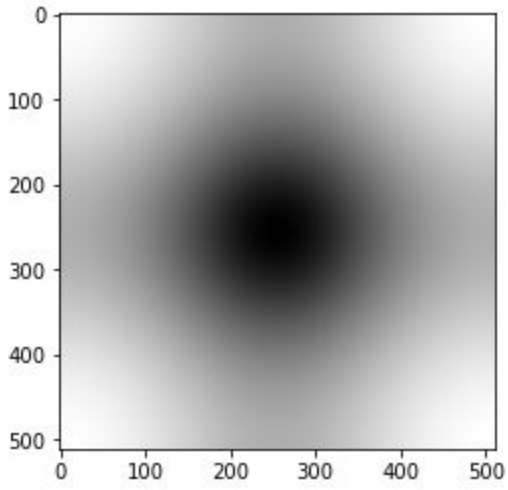
  High pass filters remove the low frequency components of an image, thereby making the edges prominent. This phenomenon is clearly evident in the filtered image.

Filter H3

- The filtered image is a low contrast dull image. This is because the filter used is a high pass filter with higher cut-off frequency than the 2nd filter (H2).
- Difference between original and filtered image in frequency domain:

  The low frequency components observed in the fourier transform of the original image are slightly suppressed in the fourier transform of the filtered image. This is because the given filter is a high pass filter as evident from its frequency response.
- Correlation between filtering effect and frequency response

  The given filter is a low pass filter as observed in the figure:



  High pass filters remove the low frequency components of an image, thereby reducing the overall contrast. The edges are not emphasized as this filter's cutoff frequency is higher than that of H2. This phenomenon is clearly evident in the filtered image.

Exercise 2

Original Image:

Noisy Image (Var: 0.01):

Noisy Image (Var: 0.1):

- **Noise level: 0.01, Filter used: Average filter (3X3)**

  Filtered Image:

- **Noise level: 0.01, Filter used: Average filter (5X5)**

  Filtered Image:

- **Noise level: 0.01, Filter used: Average filter (7X7)**

  Filtered Image:

- **Noise level: 0.1, Filter used: Average filter (3X3)**

  Filtered Image:

- **Noise level: 0.1, Filter used: Average filter (5X5)**

  Filtered Image:

- **Noise level: 0.1, Filter used: Average filter (7X7)**

  Filtered Image:

- **Noise level: 0.01, Filter used: Gaussian filter (3X3), $\sigma = 1$**

  Filtered Image:

- **Noise level: 0.01, Filter used: Gaussian filter (5X5), $\sigma = 1$**

  Filtered Image:

- **Noise level: 0.01, Filter used: Gaussian filter (7X7), $\sigma = 1$**

  Filtered Image:

- **Noise level: 0.1, Filter used: Gaussian filter (3X3), $\sigma = 1$**

  Filtered Image:

- **Noise level: 0.1, Filter used: Gaussian filter (5X5), $\sigma = 1$**

  Filtered Image:

- **Noise level: 0.1, Filter used: Gaussian filter (7X7), $\sigma = 1$**

  Filtered Image:

Discussion:

- Best filter for noise level 0.01:

  3X3 filters in both average and gaussian filters are better than 5X5 and 7X7

- Best filter for noise level 0.1:

  5X5 filter in average filters and 7X7 filter in gaussian filters are the best.

- Comparison between Average and Gaussian filters:

  We see that average filter coefficients are constant. Gaussian filter coefficients change depending on σ. Increasing σ to a large number results is better noise removal, but overly smoothes out the image, hence making it blurred. Overall, Gaussian filters give better results if an appropriate σ is chosen. But average filters are easy to formulate. Thus depending upon the requirements, we can choose any one of them.