ASSIGNMENT 1 REPORT

COMPUTER VISION

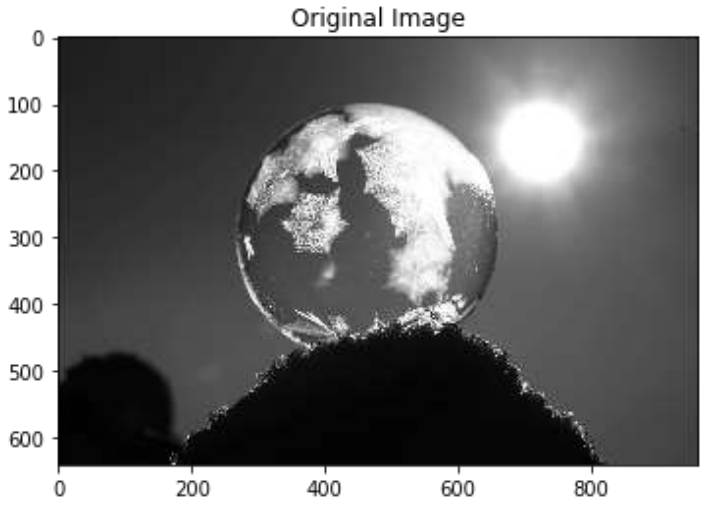
ATANU GUIN (MT19AI002)
DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING | IIT JODHPUR

Question 1: Write a function that convolve an image with a given convolution filter.

Answer: The steps for convoluting an Image with a filter is given below:

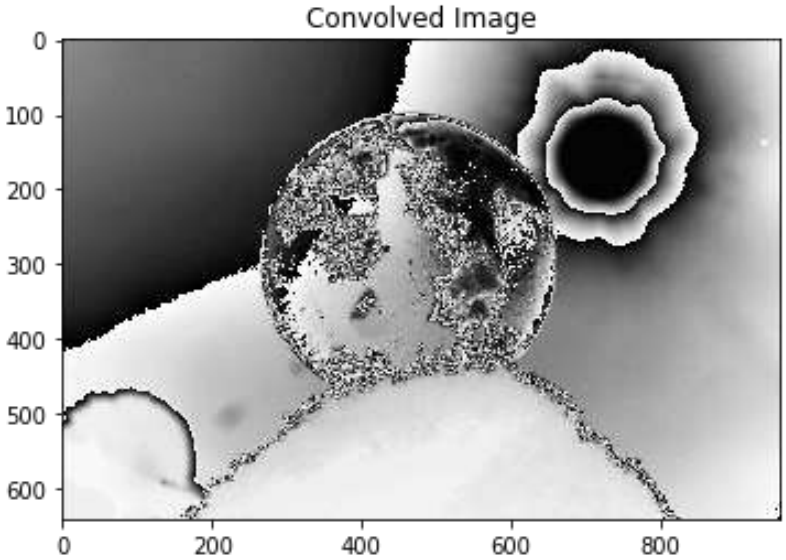
1. Created a *loadImage* function which will load the image
2. Created a *kernel* function which can get user inputs and create a kernel for convolution.
3. Created a *padding* function which takes the original image as input and return a zero padded image.
4. Created a *convolve* function which does convolution between the input image and the kernel.

The Original Image:



The convoluted Image after applying 3*3 edge detection filter:

```
[[-1 -1 -1]
[-1  4 -1]
[-1 -1 -1]]
```



Question 2:

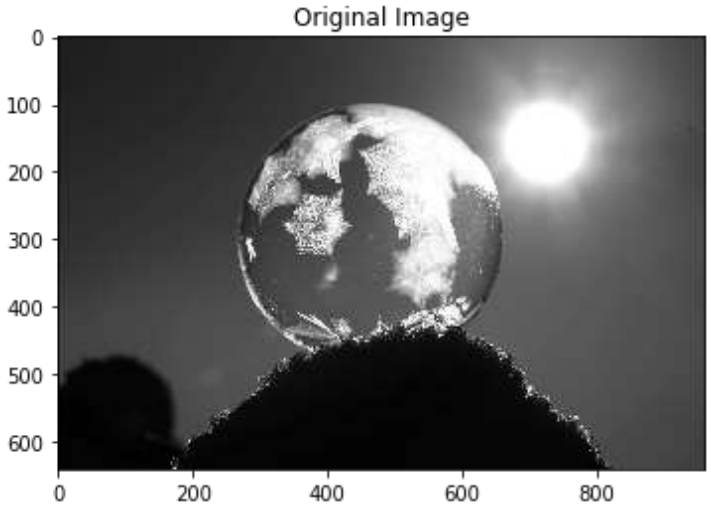
(i) Perform Gaussian filtering on image_1 with kernel size as 3x3, 5x5, 11x11, and 15x15. What is the effect of increasing the kernel size on the Gaussian filtering operation? For one of the filters, vary the σ parameter and show its effect.

Answer: The result of using Gaussian filtering on image_1 using 3x3, 5x5, 11x11, and 15x15 filters are shown below:

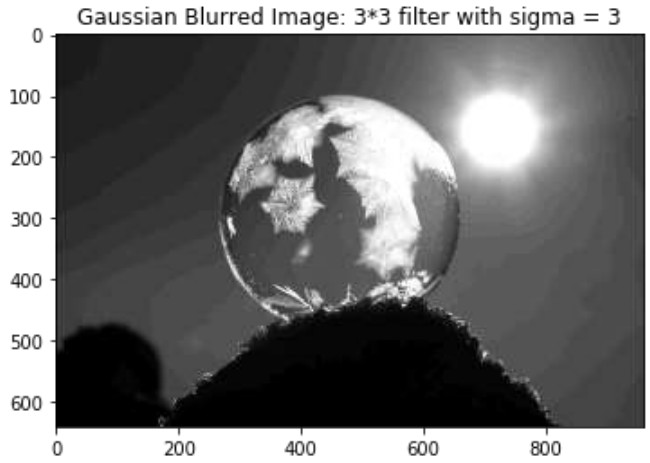
We have used **sigma = 3** for the filter.

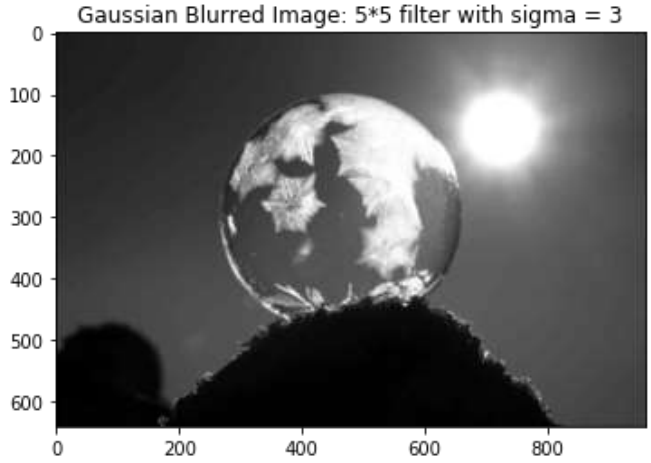
The effect of increasing Gaussian filter size is that it remove more noise from the image. So it will essentially remove more edges and gives us more blurred output. The effect can be seen below when I used Gaussian filter of different sizes.

Original Image:

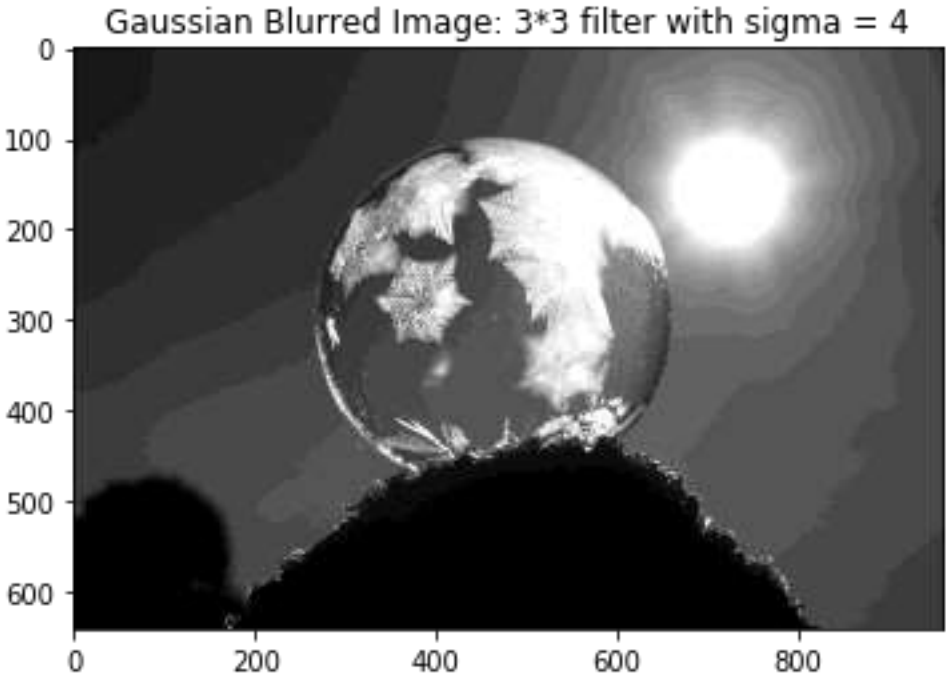


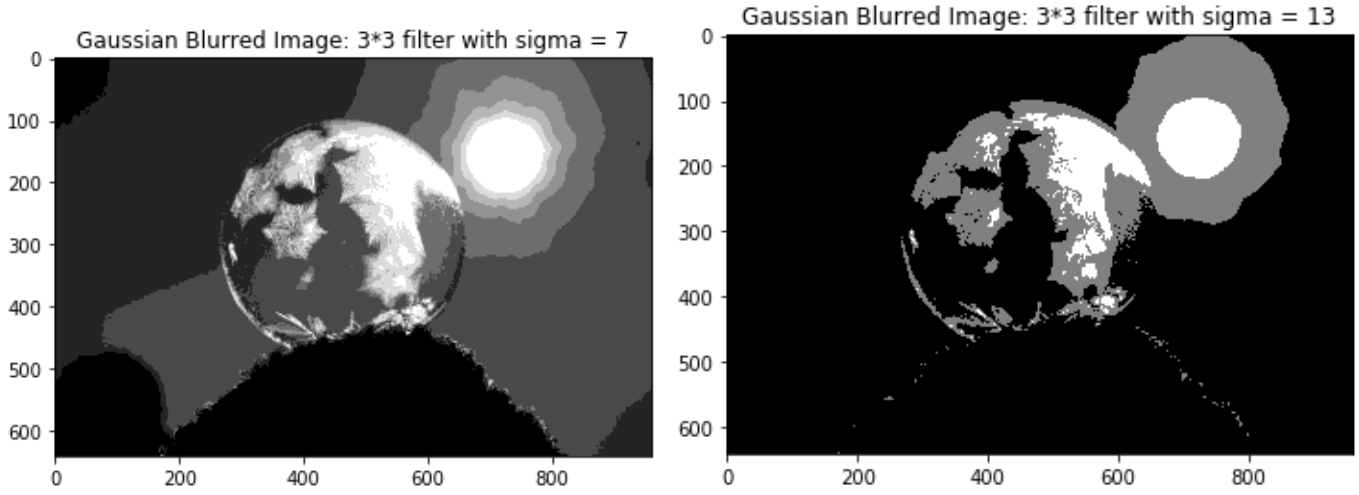
Gaussian Filter outputs:





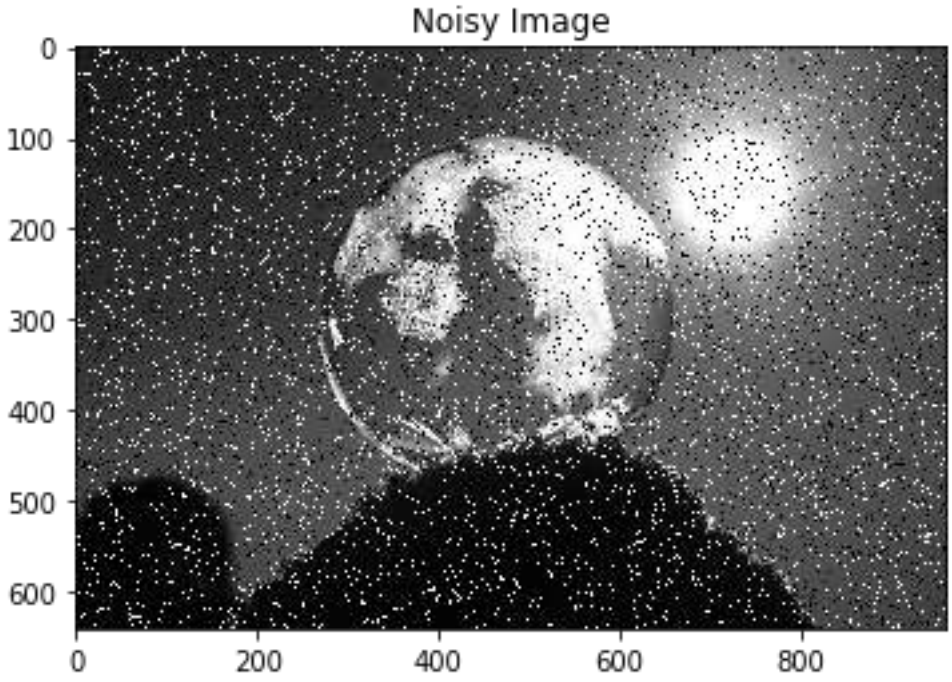
- If we increase the sigma while fixing the filter size we will change the variance of the frequency distribution around mean. So we are essentially allowing more high frequencies. The results are shown below using a 3*3 Gaussian filter and varying sigma :



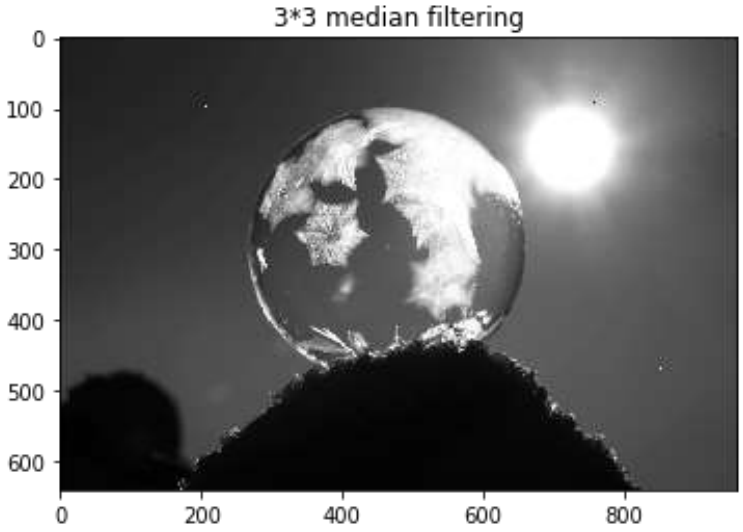


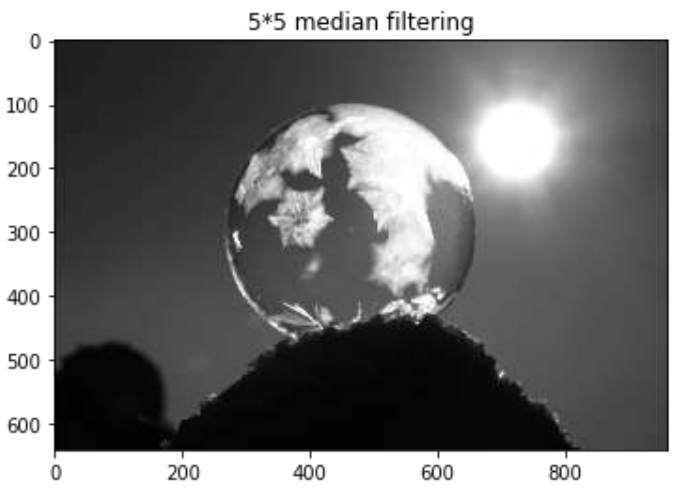
(ii) For image_1, add salt and pepper noise as 10% of all pixels. Perform median filtering on the noisy image with kernel size as 3x3, 5x5, and 11x11. What is the effect of increasing the kernel size on the median filtering operation?

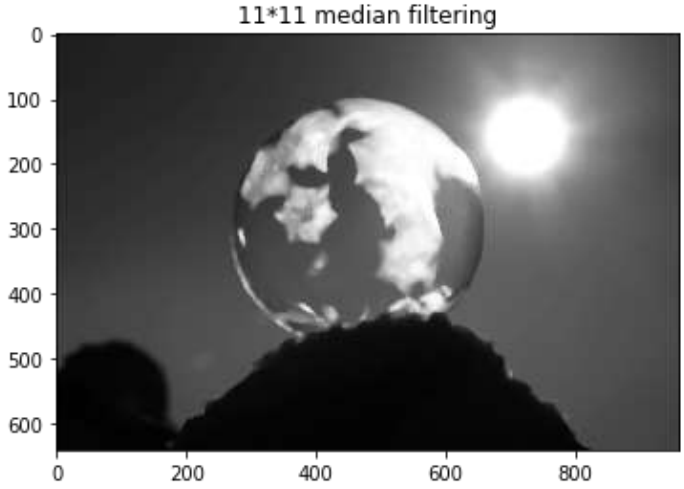
Answer: After adding 10% noise of all pixels the result is shown.



Performing median filtering, I got the following outputs: The noise has almost been removed by using median filtering.







- **Effects of increasing Kernel size on median filtering:**

  Median filtering smoothens the image. For a noisy image, if we use larger kernel size (like 11*11), we can see the noise elements get removed in one go, whereas in smaller kernel size (like 3*3), we can see some noises left. But lower kernel median filtering preserves more edge information rather than larger kernel median filtering.

Question 3: Define a sharpening and edge detection filter discussed in class. Apply the filters on image_2 in a sequence and also one by one. Report all the results.

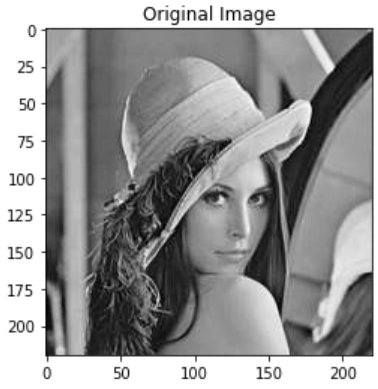
Answer: I have chosen Laplacian Filter as sharpening filter and Sobel Filter as Edge detection filter.

−1	−1	−1
−1	8	−1
−1	−1	−1

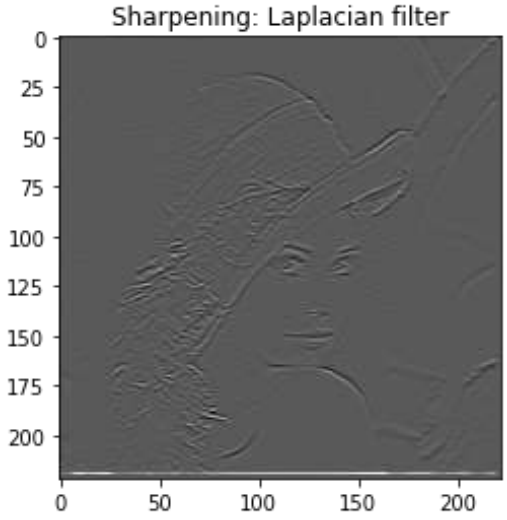
Laplacian filter

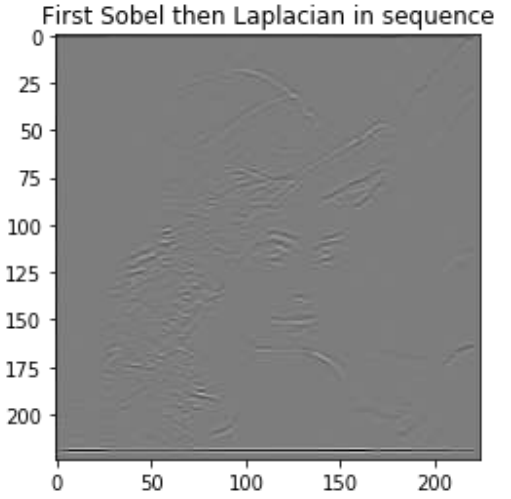
-1	0	+1
-2	0	+2
-1	0	+1

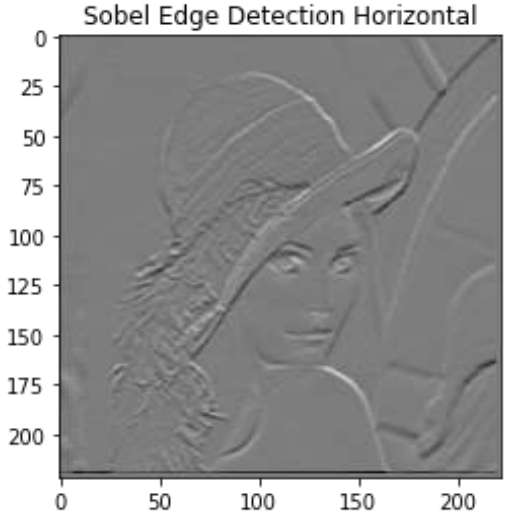
Sobel Horizontal Filter

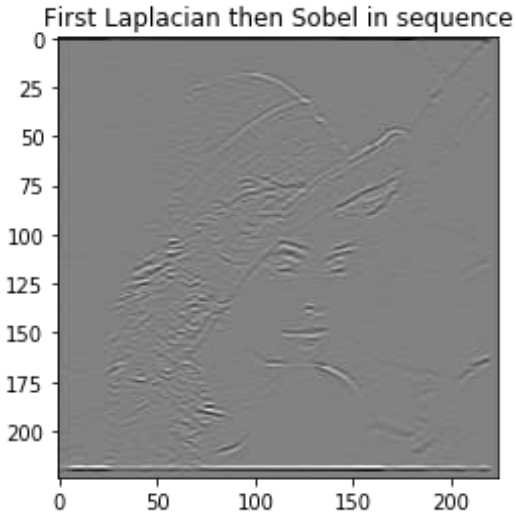


The outputs are shown below:









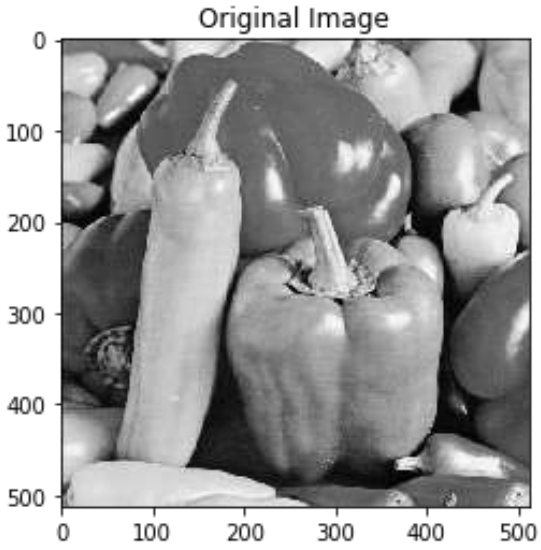
Analysis:

If we use edge detection first then sharpening then we get less edge information than if we use otherwise. Since sharpening gives more high frequency information at first and if we use edge detection after it, the edges become more prominent than the other way around.

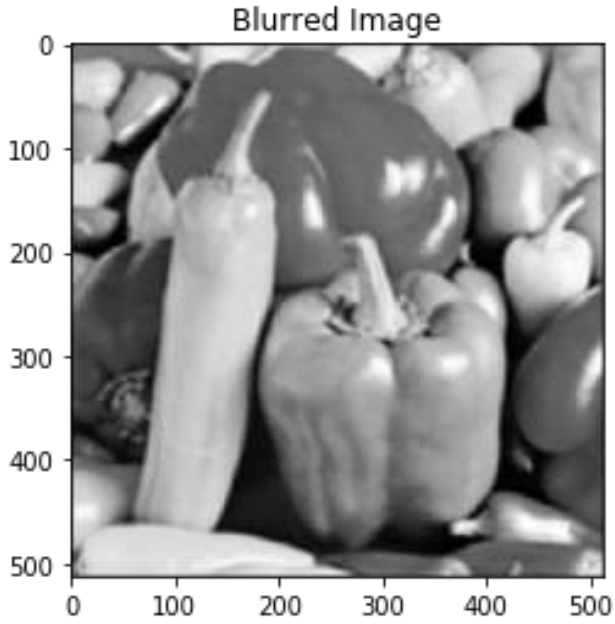
Question 4: Perform unsharp masking on image_3. Use Gaussian filter of size 7x7. Report all the intermediate results.

Answer: The result after using Unsharp masking is given step by step as below:

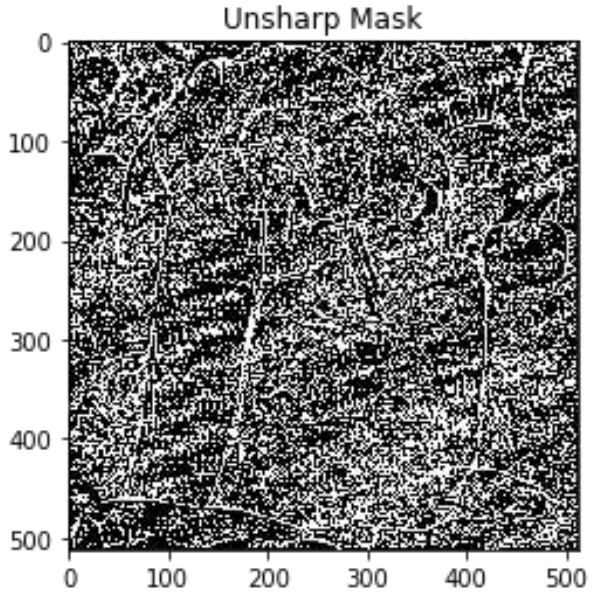
Step1: First, I started off with image_3.



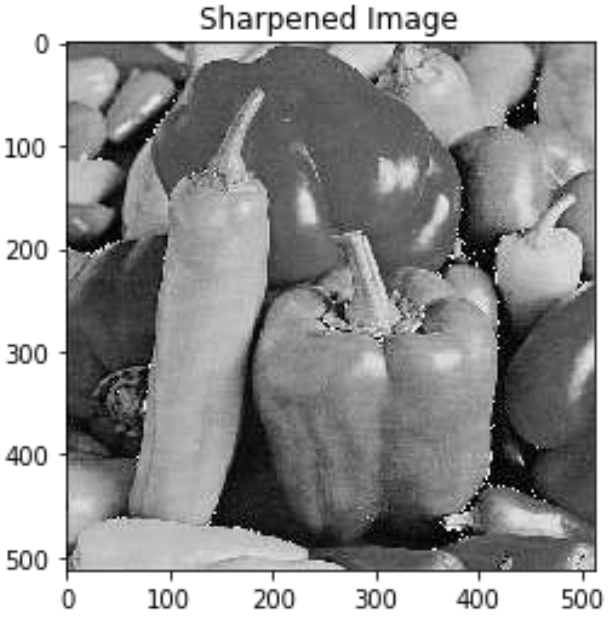
Step 2: Now I have applied Gaussian Filter of size 7*7 with sigma = 1. This has given me low-pass information of the image.



Step 3: Now, I have subtracted this low pass image from Original Image to get only the high frequency pixels.



Step 4: Now, added this high frequency image to original Image to get a sharpened image.



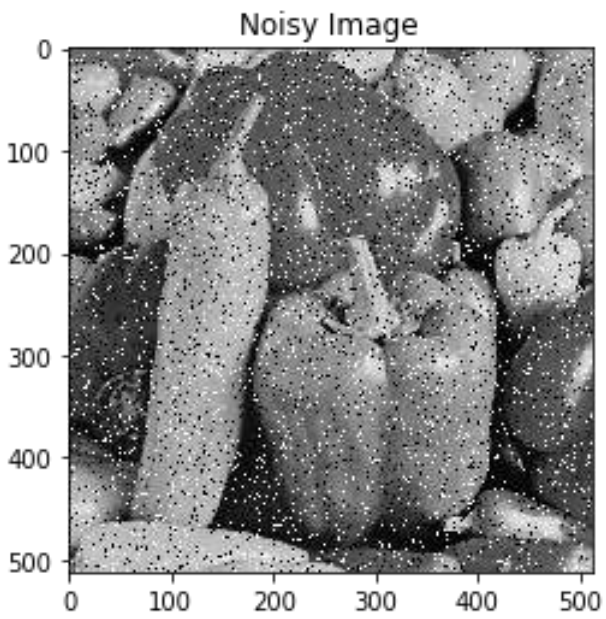
Question 6: Let image_3 be I. Perform the following operation to image I: I'=I+SP+L(I), where, SP is salt and pepper noise while L(I) signifies the Laplacian filtering output of I. Perform wavelet decomposition using either of the following wavelet filters: (a) Haar (b) db 9/7
and, remove the high frequency components to obtain a smooth image in spatial domain.

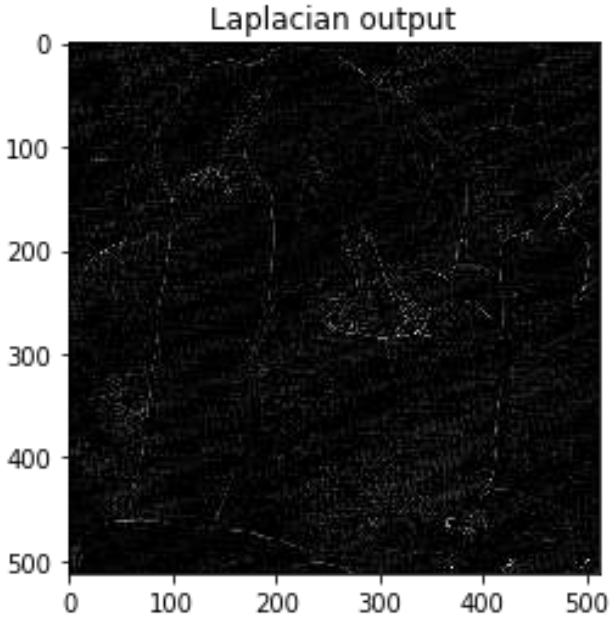
Answer: I have used Haar wavelet decomposition on this problem.

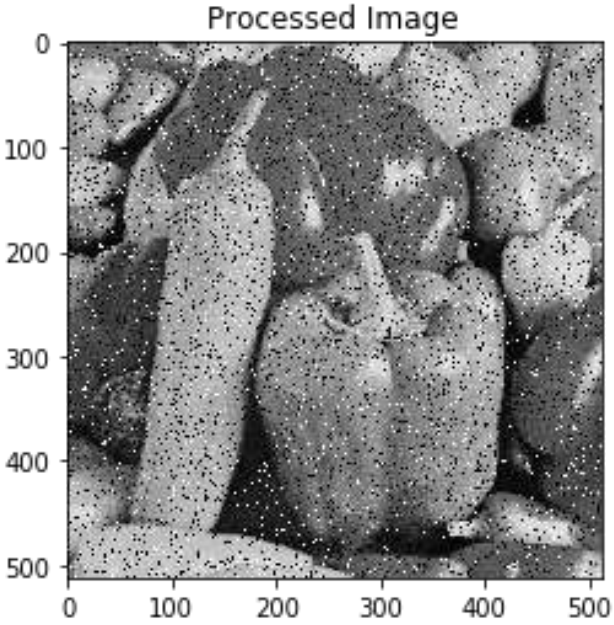
Step1: For this problem I have used 10% salt-pepper noise on image_3.

Step 2: Also done Laplace filtering on image_3 to get L(I) which gives the high frequency components of the image.

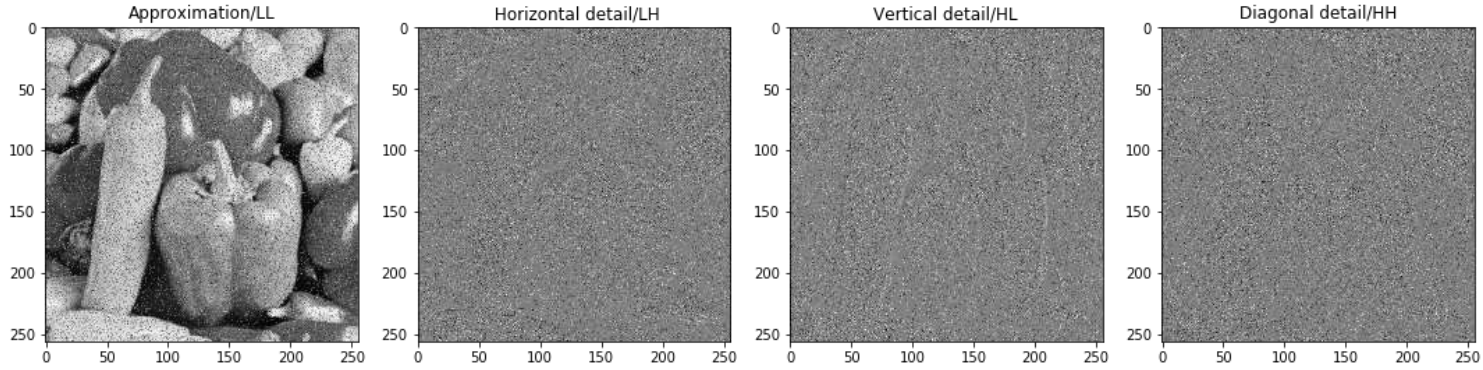
Step 3: Add both of the above output images to get I'=I+SP+L(I).



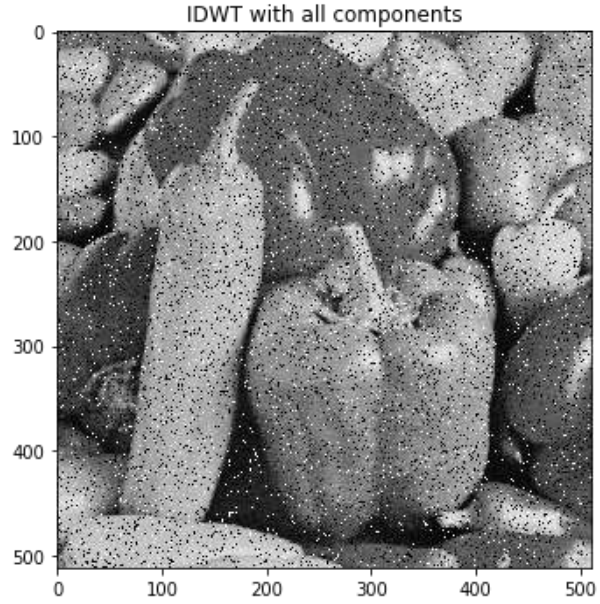


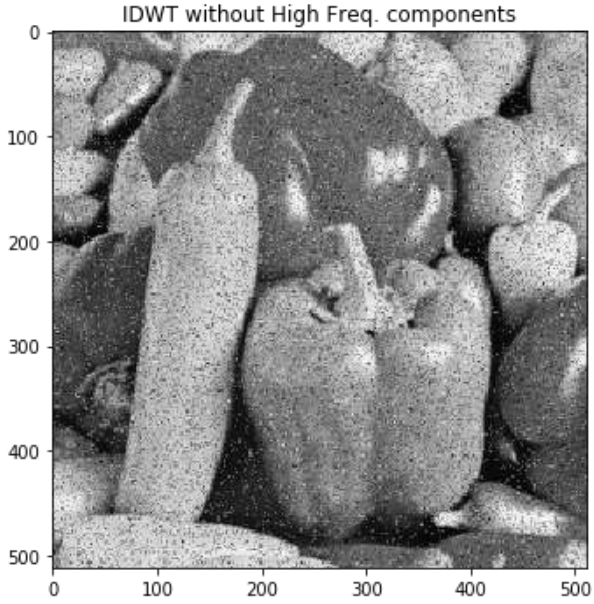


Now, I have applied 1 level of Haar Discrete Wavelet Decomposition on this Processed Image. The four frequency components (Low-low/Low-high/High-Low/High-High) are shown below.



Performed Inverse Discrete Wavelet Transform (IDWT) once by combining all the frequency components and also removing all high frequency components except Low-Low.





We can see from the above two images that the salt noises have been removed. Also the image has become blur (smooth) since all high frequency components have been removed.