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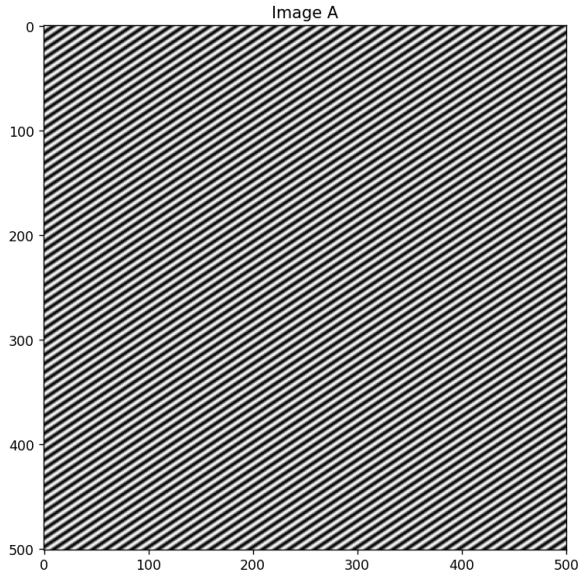
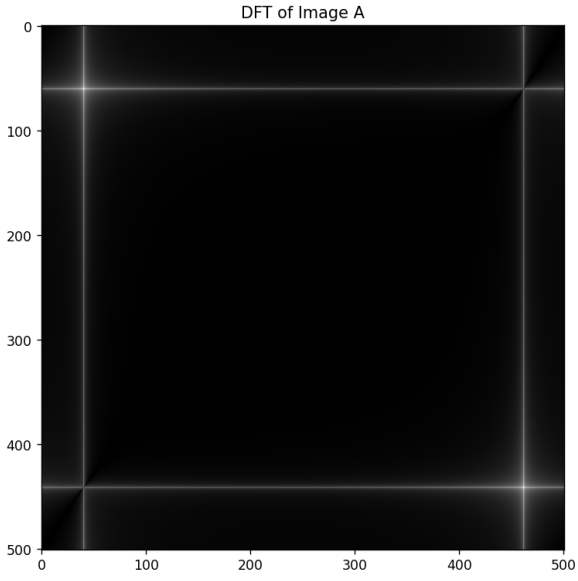
Programme - M.tech
Stream- Signal Processing
SR no - 21117
Assignment - 3

Note :

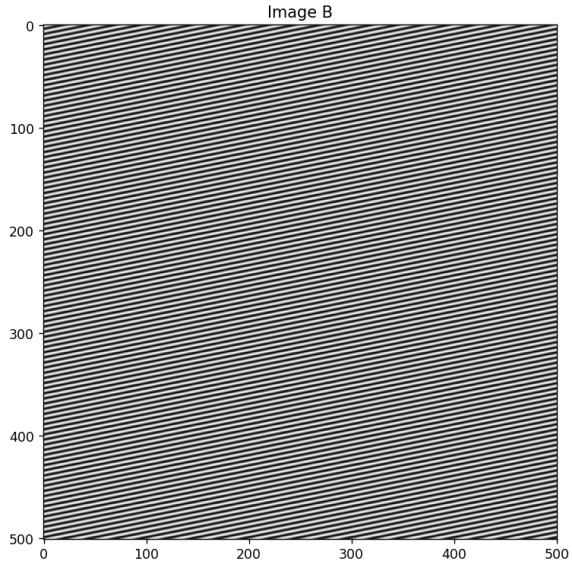
1. To run the code first extract the zip file and then open wrapper.py. After running wrapper.py hit the Enter key and see the output. After analyzing the output close all picture windows and hit Enter again for the next program.
2. To run the first program enter 1 and for the second program enter 2 and so on.
3. I have used Visual studio code to write code, and the codes are working properly on VS code and may cause some errors on different IDEs having different versions of prerequisites.

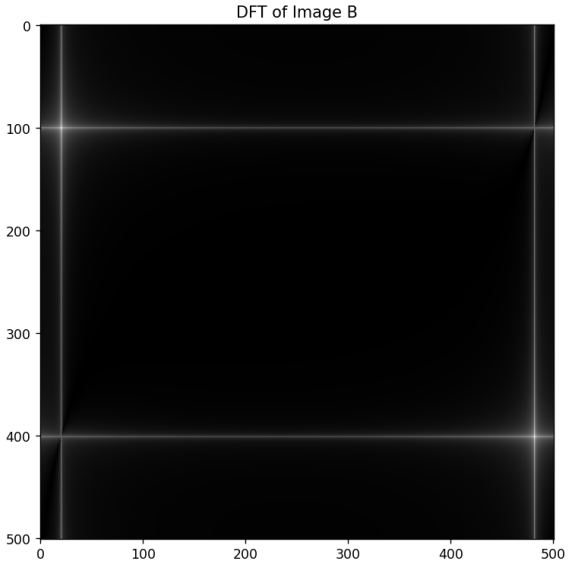
Q.1 (a). Observations: (i) Two-dimensional sine wave peak and tough occur diagonally. The superposition of two-dimensional sinusoidal projection lies in the spanning set of the x-axis and y-axis.



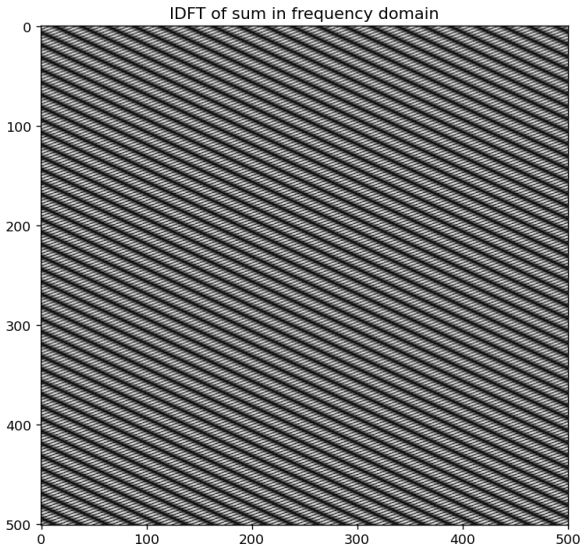


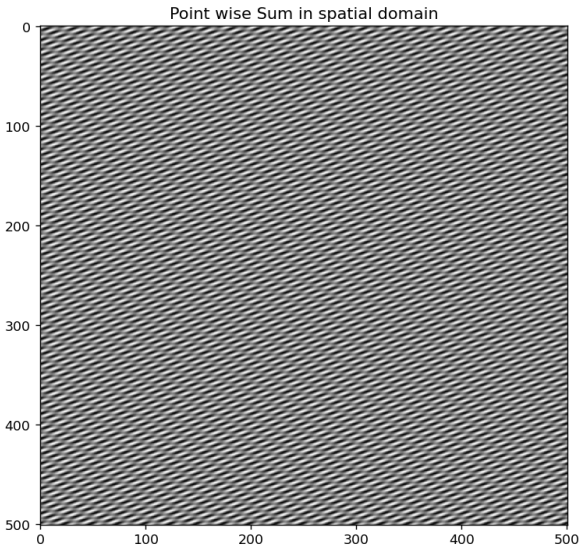
Since then this wave can be created by only one sine wave having a certain frequency hence its frequency domain should contain only two impulses. We all know that the DFT of a sine wave contains two impulses. These two impulses are shown in the second picture, some margins are also appearing due to some unknown anomaly of module functions.





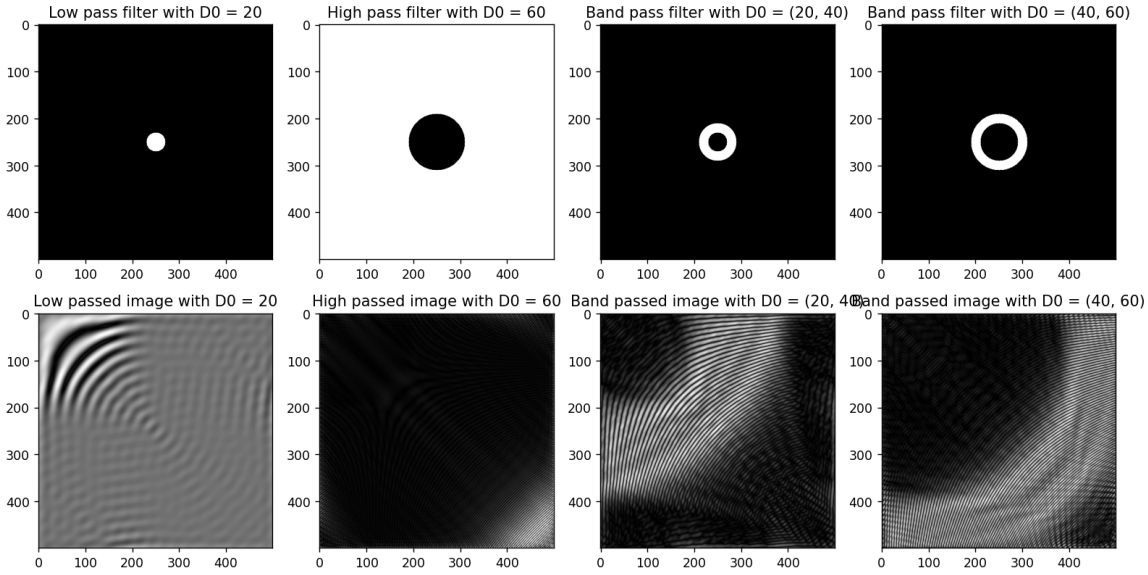
(ii) Now in the second task u,v = (20, 100) coefficient corresponding to the x-axis decreased and the y-axis increased hence in the DFT frequency domain the real value of frequency decreased and the imaginary value increased.





(iii) IDFT of the sum of two frequency domain images give more sharp image than the pointwise spatial addition of two images. The frequency domain tells how pixels' intensity in varying in frequency domain addition frequency value enhanced and pixel intensity variation becomes more clear. In spatial domain addition pixel intensity increases or decreases only.

Q. 1 (b) Observations:



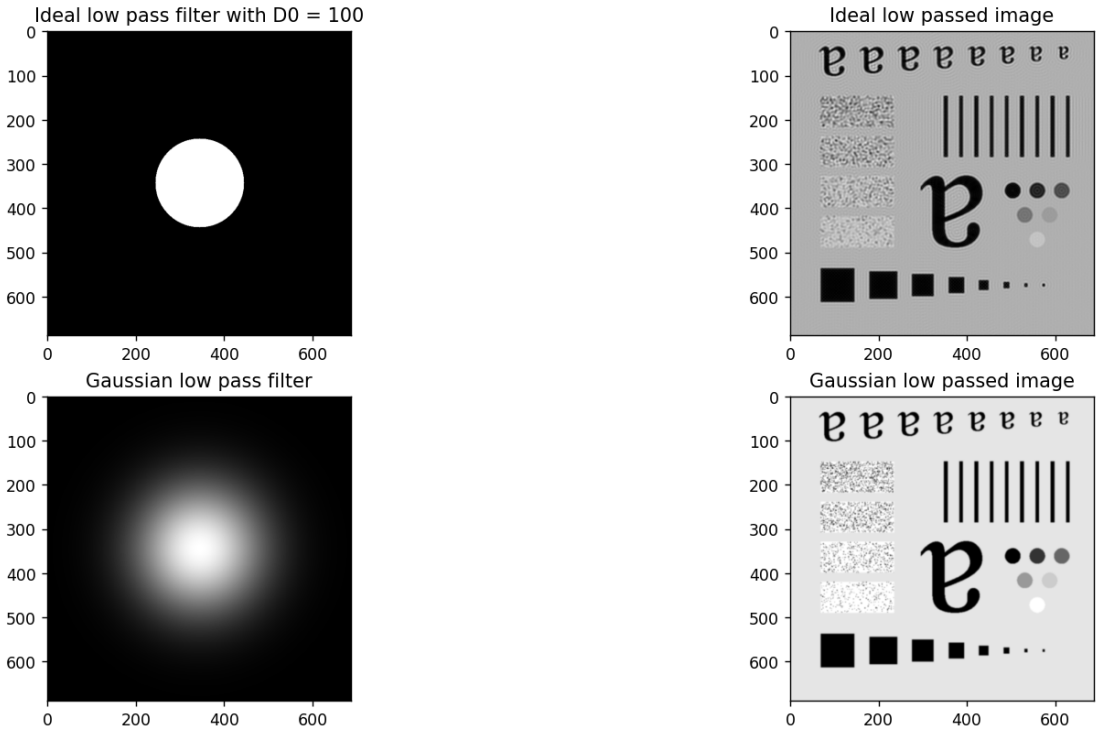
(i) I deal low pass filter value should be one till the threshold and ideal high pass filter value should be zero till and this we can see in the output plot of filters. The bandpass filter has the annular region having value one and the remaining zero. Now when we filter the given image with a low pass filter we see a smooth image output. This filter has a very less cut-off value hence the variation of the original pixel intensity gets filtered out. But when we increase the cut-off value of the filter the output becomes more clear. In the top left corner the image has very less pixel intensity variation hence frequency is less, so in the filtered image we are able to see some part of the top left corner of the image.

(ii) In the bottom right corner of the image is sharp, in this region frequency will be high. We pass with the ideal high pass filter we get only this region because it has a high frequency. Other regions are smooth and have less frequency.

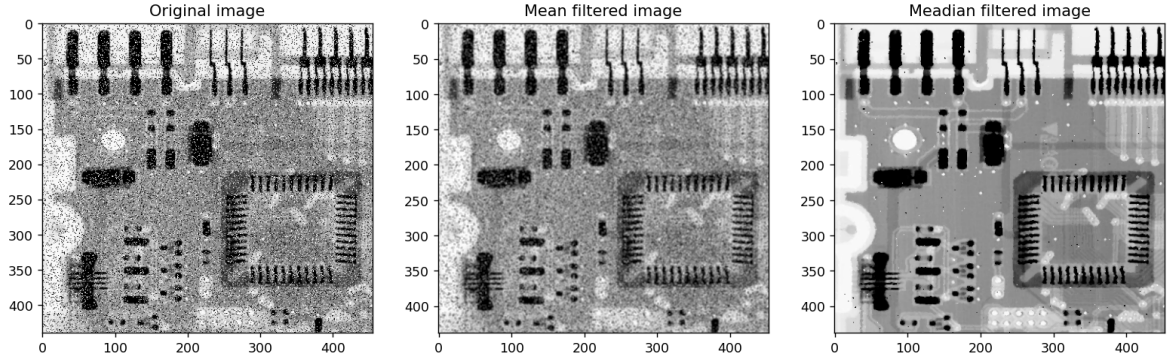
(iii) The bandpass filter allowed a certain range of frequency hence in the output of the filtered image we can see some similar intensity level pixels. The given image becomes sharper when we move along with its principal diagonal. The first bandpass filter allows less frequency value and the second filter allow a higher value. So the first filter is giving less variation zone and the second gives a zone having more variation.

Q. 1(c) Observation(s):

(i) Ideal low-pass filtered image is a little faint in terms of intensity. There are some visible contours around the character in low pass filtered image. The edges of characters contain high frequency and low pass filters do not allow them hence we see these types of artifacts. Gaussian is a smooth filter so, the output is more smooth and it allowed high frequency by reducing the amplitude, hence we are not getting these types of artifacts. In comparison to the original image gaussian filter gives the more smooth image.
Output :

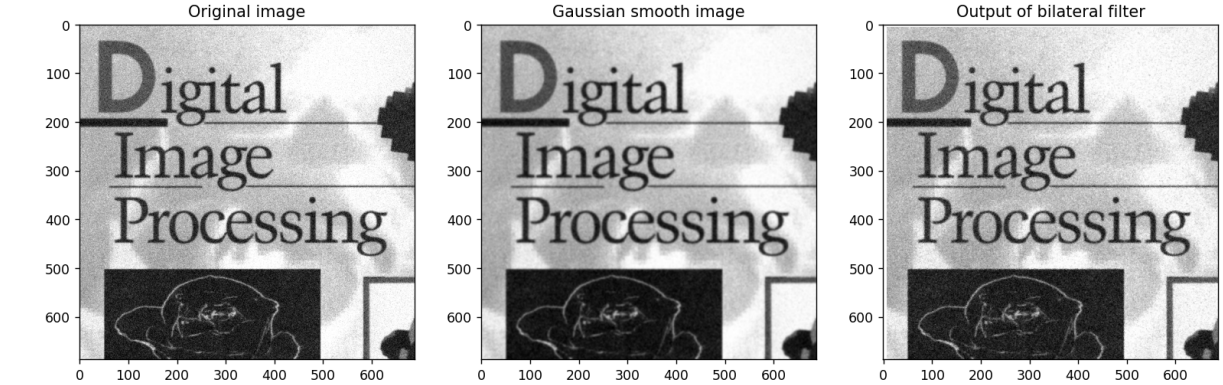


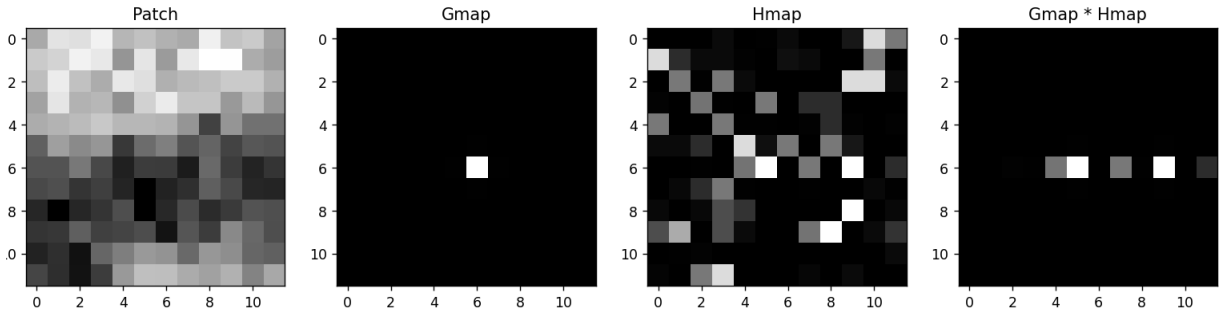
Q. 2 (a) Observation(s):
(i) Impulsive noise arises due to abrupt high change in intensity of a pixel. These pixels behave like impulses. The mean filter takes an average of pixel values in a patch. In the given image in a patch, most of the pixels have average intensity values and some pixels have high impulsive values. After the application of the mean filter, we are getting an average level of intensity, but the image is not much clear because the average filter alters those pixel value that has the relevant information. The median filter gives the intensity value which is occurring most frequently in a patch. Impulsive noises are less in comparison to the average intensity value. So median filter replaces all pixels in a patch by the most frequently occurring intensity and it ignores the impulsive noise. Although sharp lines/ edges/ corners in the patch get a little distorted but, it gives better results in comparison to the mean filter.
Output:



Q. 2 (b)

Output :

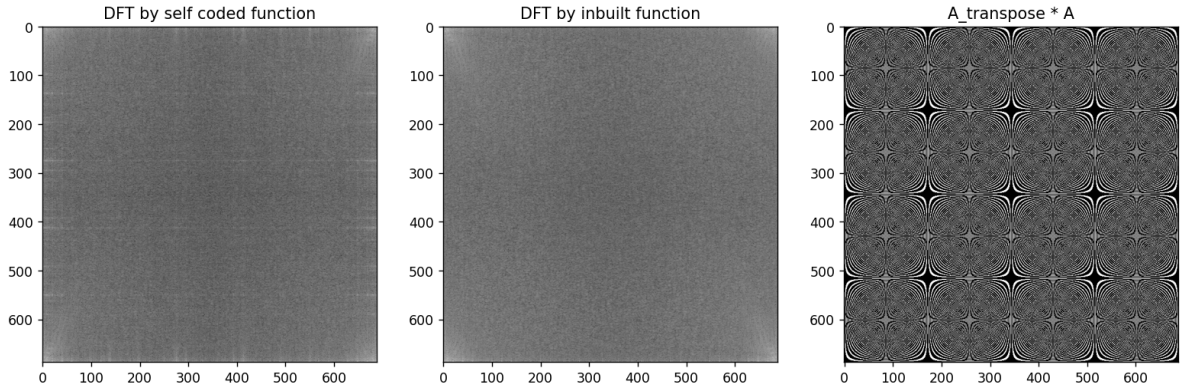


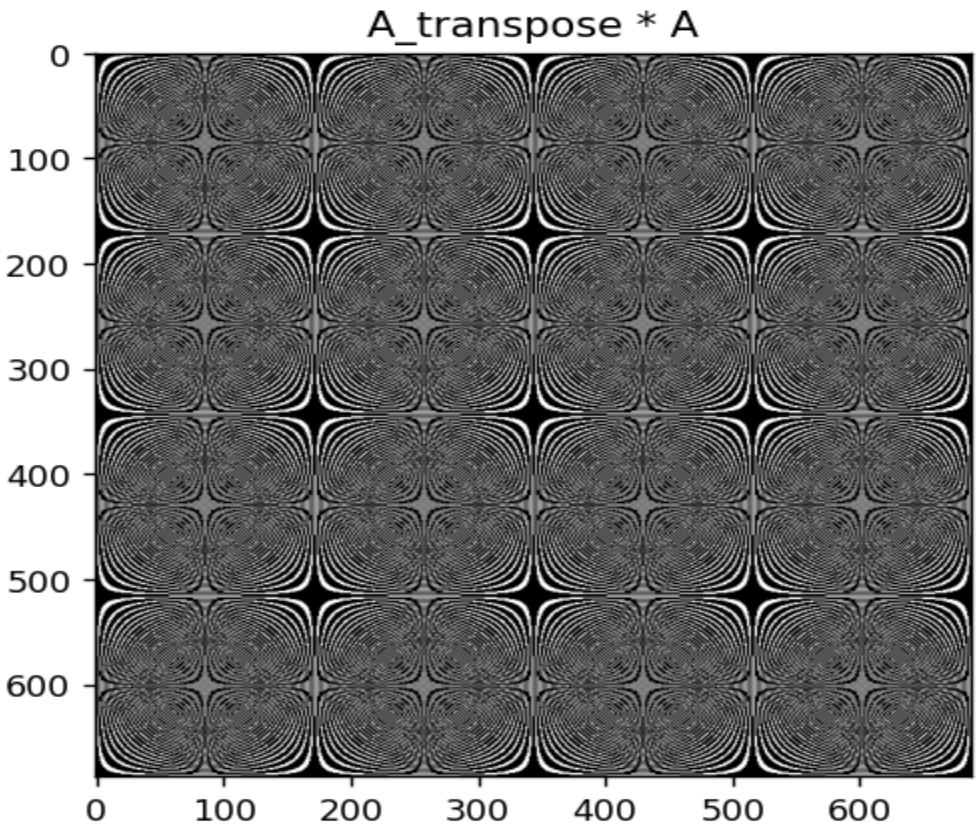


Observation:

(i) For a pixel Gmap * Hmap tells about the neighbor pixels intensity variation with gaussian weight. As the distance increases weight decreases.

Q. 3 Output:
Outputs are plotted with a title.





Observations

(i) Although the original image and inverse DFT of the DFT calculated image are the same still MSE is high. MSE calculates for each pixel and hence the error is very large. It is reflecting that MSE is: 45545741890.7135.

(ii) A^h * A not giving much visible data in the plot, but when we round off the twiddle factor matrix then it shows some pattern. In the output of this plot, we can see many same types of small regions with circles having different radii. Twiddle factor involves complex exponential and complex exponential forms a circle having a radius depending on the real value. Cells are repeating because our exponential is two-dimensional and periodic for fix value of the real number.

(iii) If we break 2D DFT then we will get two joint one-dimensional DFT having orthogonal axes. This orthogonality can be handled by taking the transpose of the matrix, and by writing A^T * A we are dealing with a two-dimensional DFT operation hence we are getting output.