IMAGE FUSER

Problem:- Write the equations governing 2D discrete variable Fourier transform. Use the Python programming to directly calculate (using available library functions) 2D Fourier transform of any one of the input images given to you, plot its magnitude spectra in normal form and in dB form. Where is this spectrum centered at? Can you shift it to make lower frequencies located at center of 2D transform.

Rotate the input image anti-clockwise 90-degrees and plot its 2D Fourier transform magnitude spectra. Compare this spectra with original image's spectra, write your observations.

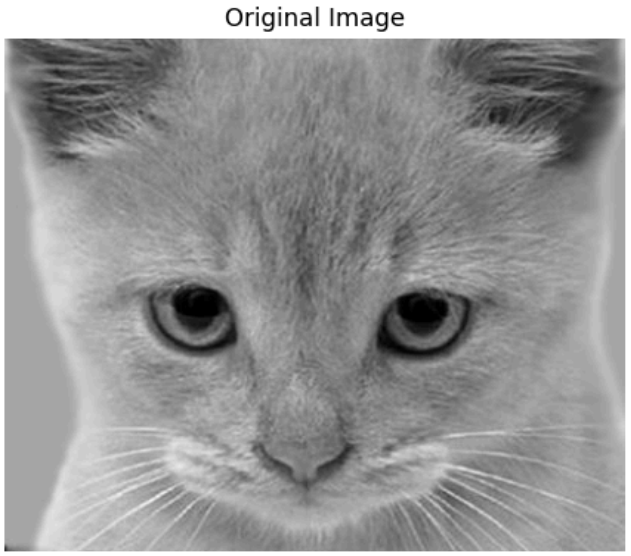
Write a Python code to creatively fuse the given two images, One provides the fine details and the other provides the overall structure of the image.This will result in a new image where different frequencies contribute to different perceptual information. Write all the details and transfer function 2D plots of your designed system. This system is known as frequency mixer.

Solution:-

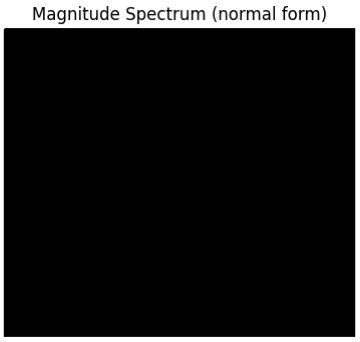
$$F[k,l] = \frac{1}{MN} \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} f[m,n] e^{-j2\pi\left(\frac{k}{M}m + \frac{l}{N}n\right)}$$

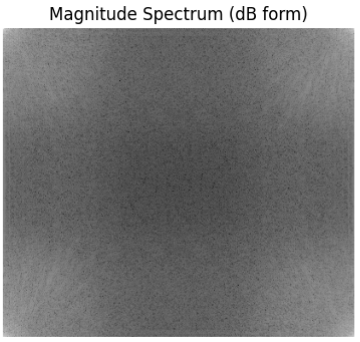
Equation of 2D discrete Fourier transform

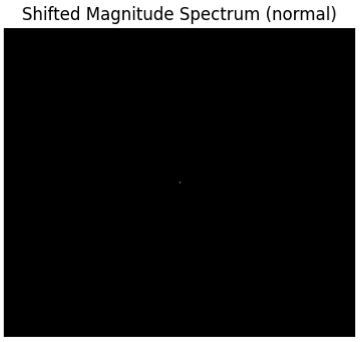
Thishelps us to convert the image data into its frequency domain so that analysis becomes easier and we can modify in the frequency domain to see the changes in the image.

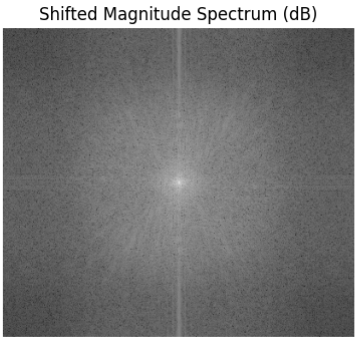


2d FFT places the low frequency at the corners making it very difficult to analyse so we use shifted function make the low frequencies at the center.Helping us to apply domain wise filters such as high pass and low pass etc.



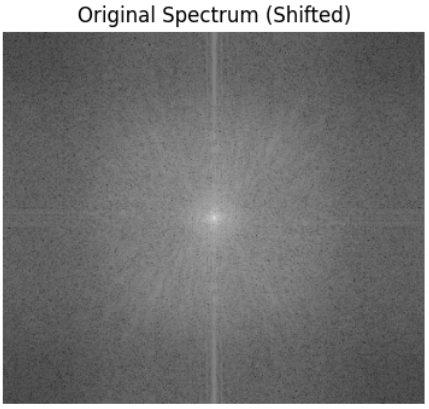


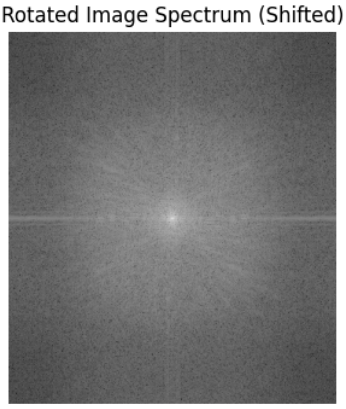




Notice a time dot in the shifter mag spectrum in normal form.

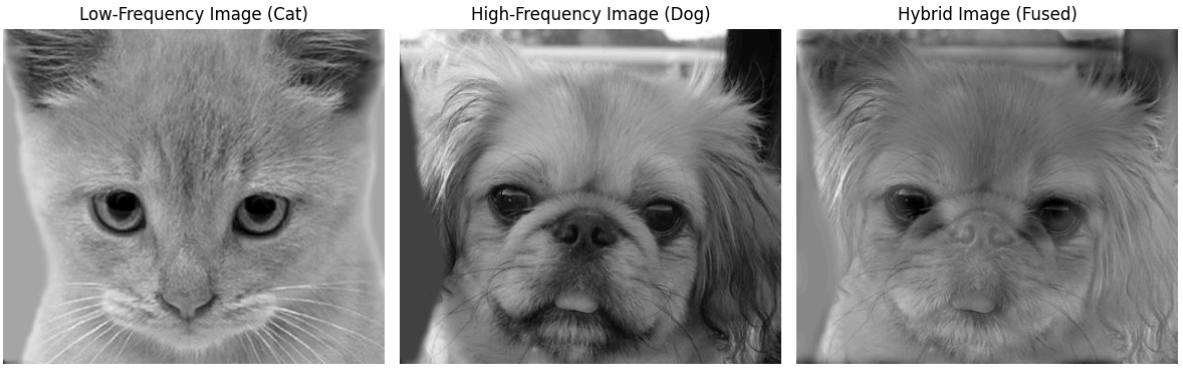
When a image goes a 90 degree roation then in frequency domain also it goes a 90 degree rotation. This is the property of Fourier transform as we rotate in spatial domain it automatically gets rotated in frequency domain.





Fuser Logic:- Here the provided images the cat image has less edges so i preferred it to have the colour gradient and made it through lowpass filter and Dog's image has more edges so made it through a high pass filter so that the edges in the dogs remain significant and the gradient of cat remains.we used a circular mask in the frequency domain to extract

the low-frequency information from one image and merge it with the high-frequency components of another. This creates a fused image that retains the overall layout of the first image while embedding sharp details from the second.



Filter:- i used a gaussian filter with a cutoff radius of 10

$$H_{\text{low}}(u,v) = \exp\left(-\frac{(u-u_0)^2 + (v-v_0)^2}{2\sigma^2}\right)$$

Gaussian low pass filter. Here the u0 and v0 are the center similarly the Hhigh will be 1-Hlow so that will be multiplied with the dogs image array and Hlow will be multiplied with cat array.