15EEE337 Digital Image Processing

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Last Lecture

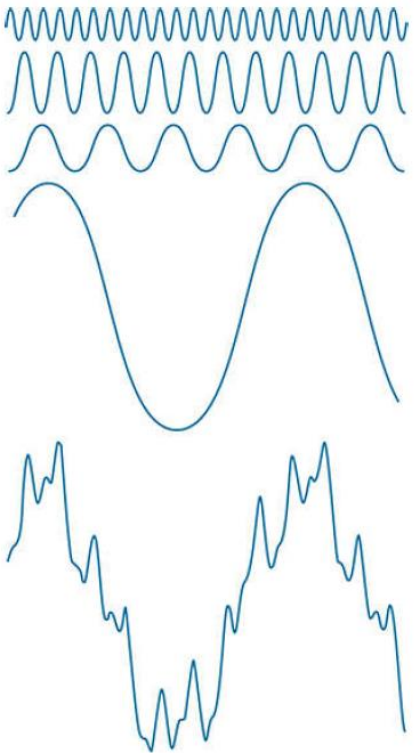
- Sharpening spatial filters
- Unsharp and High boost filtering

Image Transform

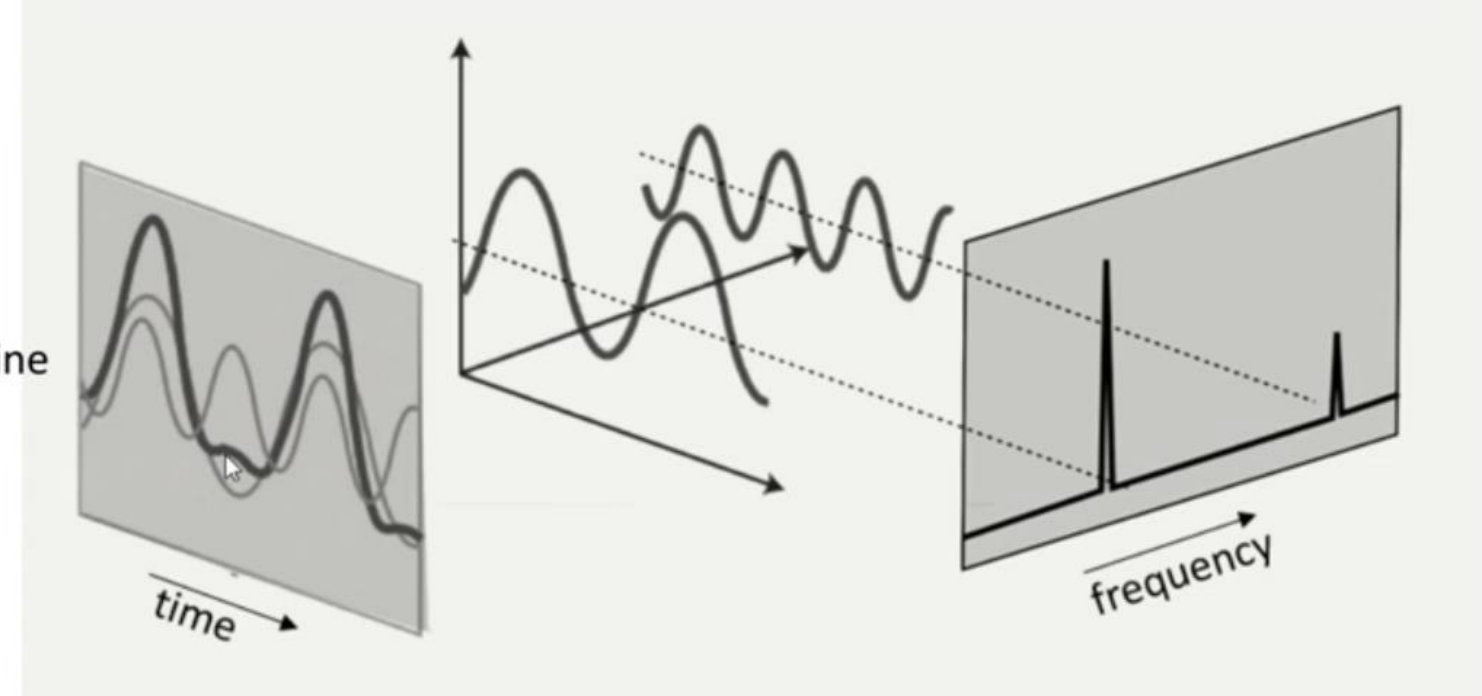
- Till now we limited operations in spatial domain.
- *Why we need to change from spatial domain?*
- An image transform can be applied to an image to convert it from one domain to another. Viewing an image in domains such as frequency domain enables the identification of features that may not be as easily detected in the spatial domain

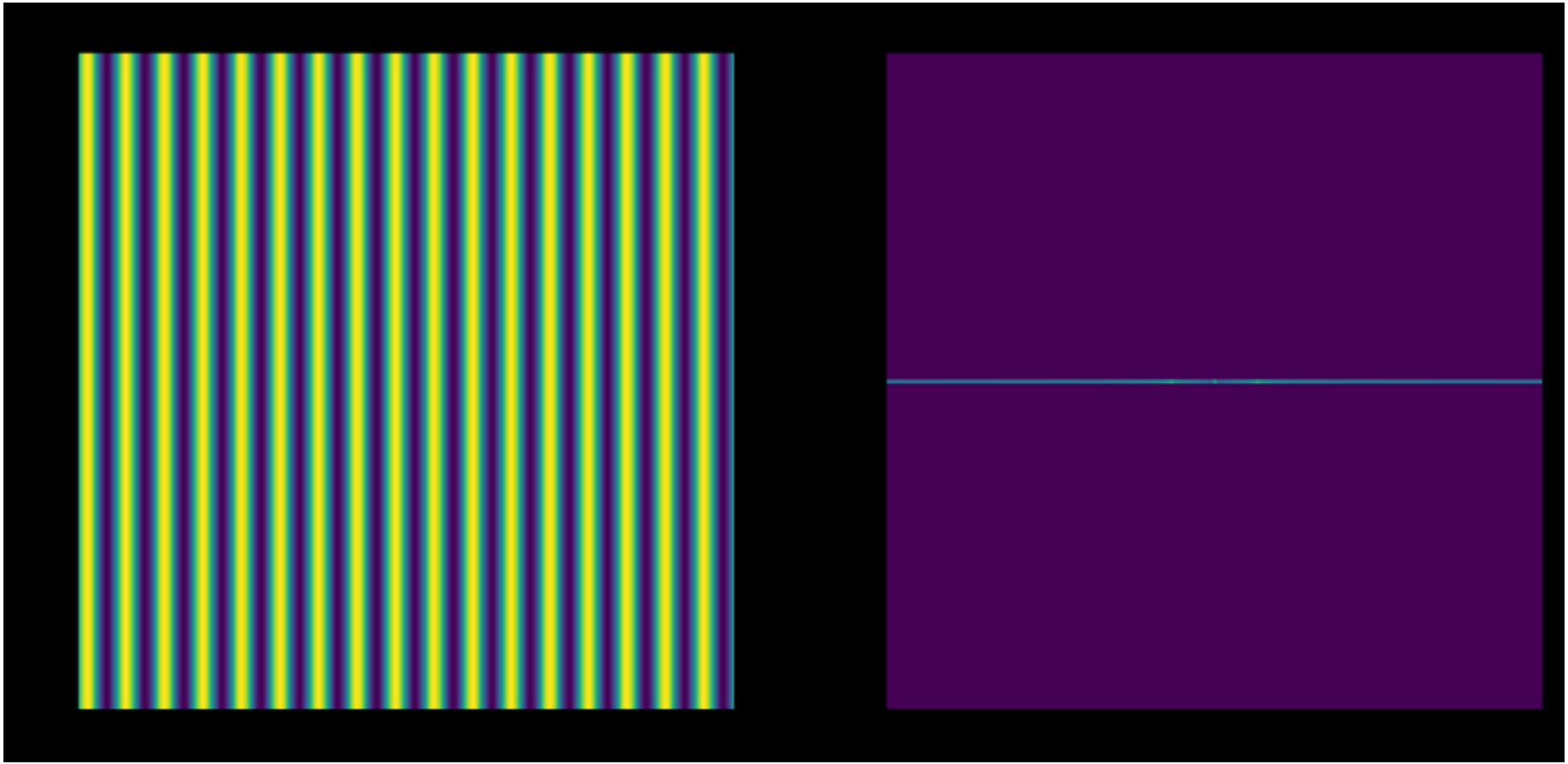
Fourier Transform

- Any periodic function can be expressed as the sum of sines and/or cosines of different frequencies, each multiplied by a different coefficient
- An important property – a function expressed in Fourier series or transform can be reconstructed via an inverse process with no loss of information.
- Switch from Fourier domain to original domain without losing any information.
- The Fourier Transform is an important image processing tool which is used to decompose an image into its sine and cosine components.
- The output of the transformation represents the image in the Fourier or frequency domain, while the input image is the spatial domain equivalent.
- In the Fourier domain image, *each point represents a particular frequency contained in the spatial domain image*.



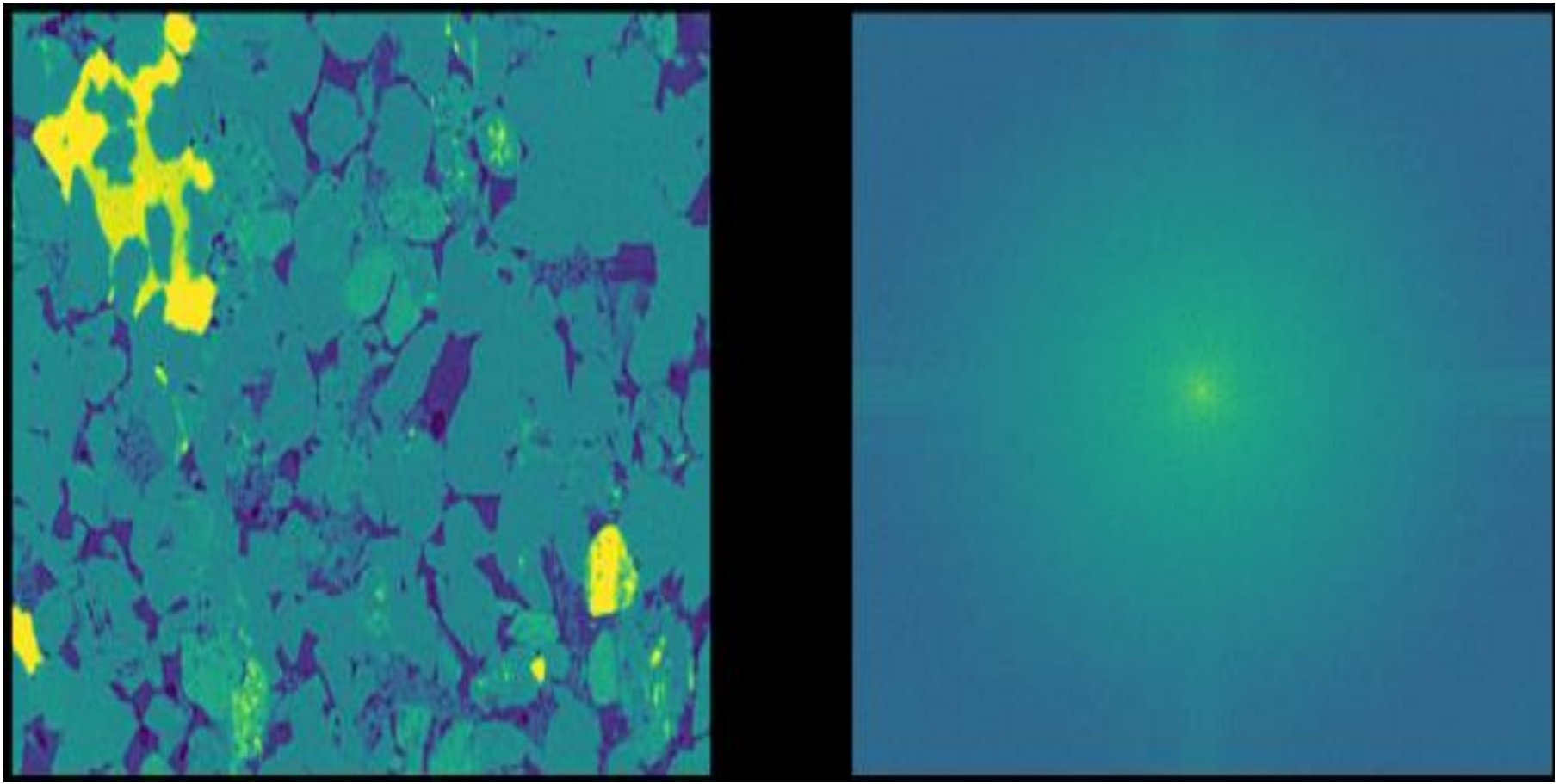
Mixture of individual sine waves with different frequencies





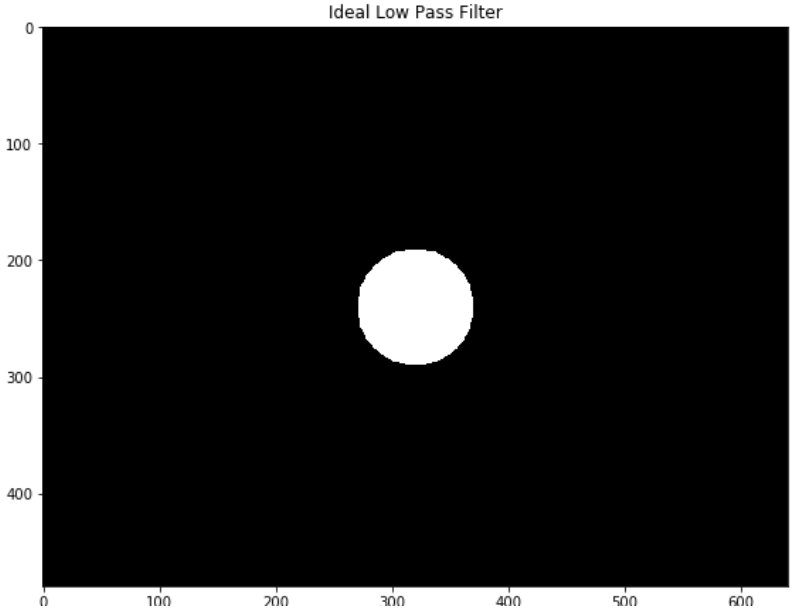
- FT breaks a function/signal into alternate representation using sine and cosine
- Individual images and reconstructed
- Continuous FT
- But digital Image is discrete so we focus on DFT.
- Relevance
  - The output of DFT→ center represents low frequency component
  - Outer regions represent high frequency components
  - Edges – high frequency
  - To extract edges we can mask the contribution from center.

- We are only concerned with digital images, we will restrict this discussion to the *Discrete Fourier Transform* (DFT).
- The DFT is the sampled Fourier Transform and therefore does not contain all frequencies forming an image, but only a set of samples which is large enough to fully describe the spatial domain image.
- The number of frequencies corresponds to the number of pixels in the spatial domain image, *i.e.* the image in the spatial and Fourier domain are of the same size.



Lets try FT on images!!!!

- Points to remember
- Shifting of FFT.
- Masking
- Convolution in spatial→ multiplication in frequency domain.


Ideal Low Pass Filter
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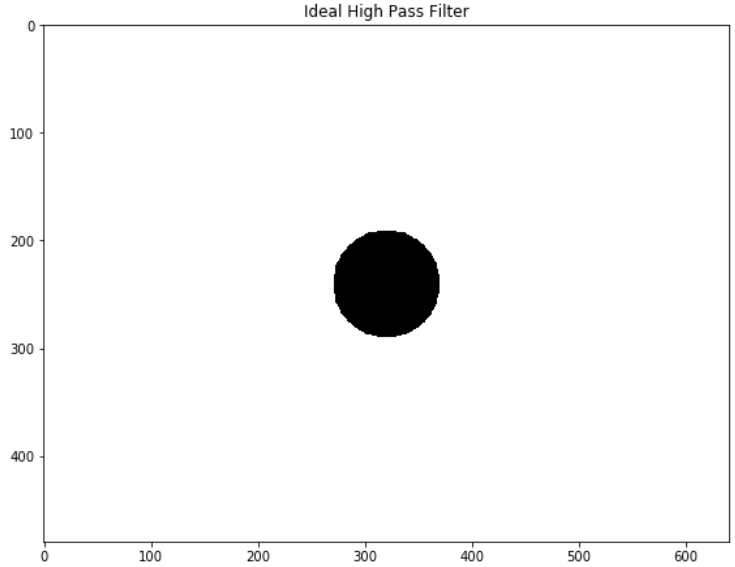
Ideal High Pass Filter
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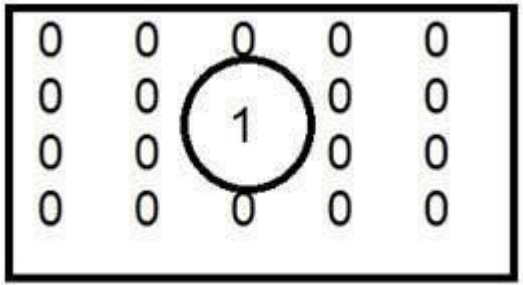
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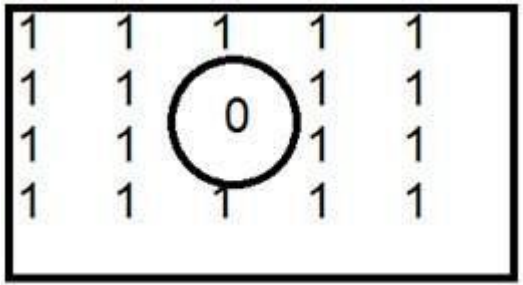
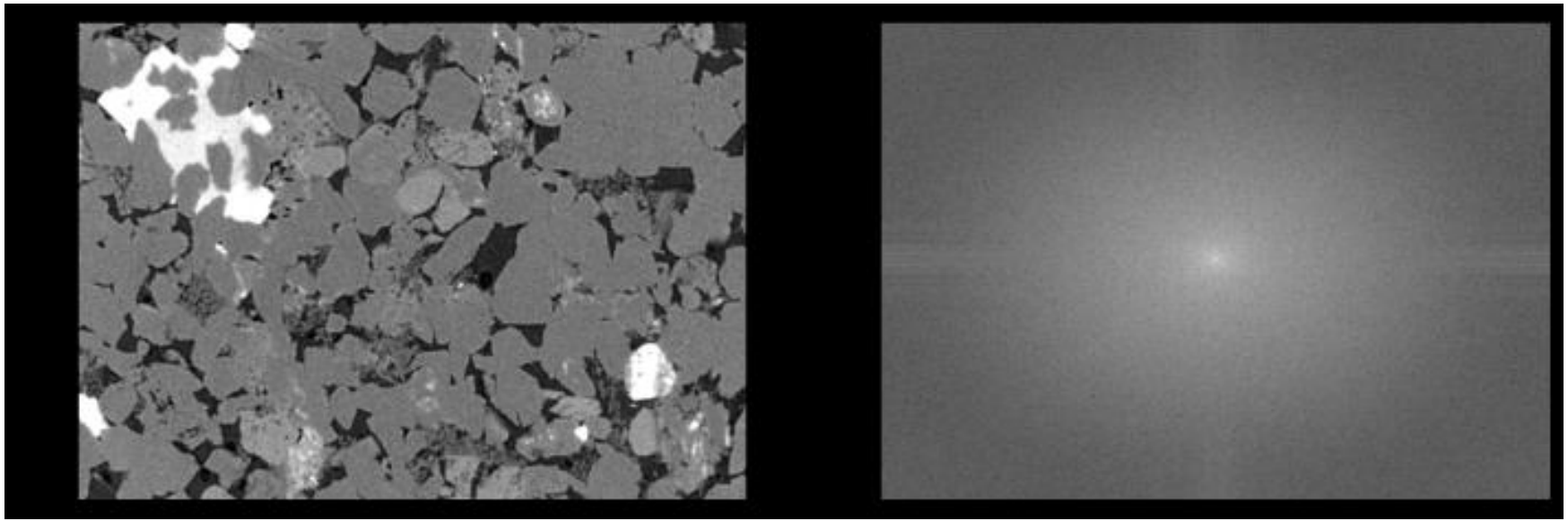
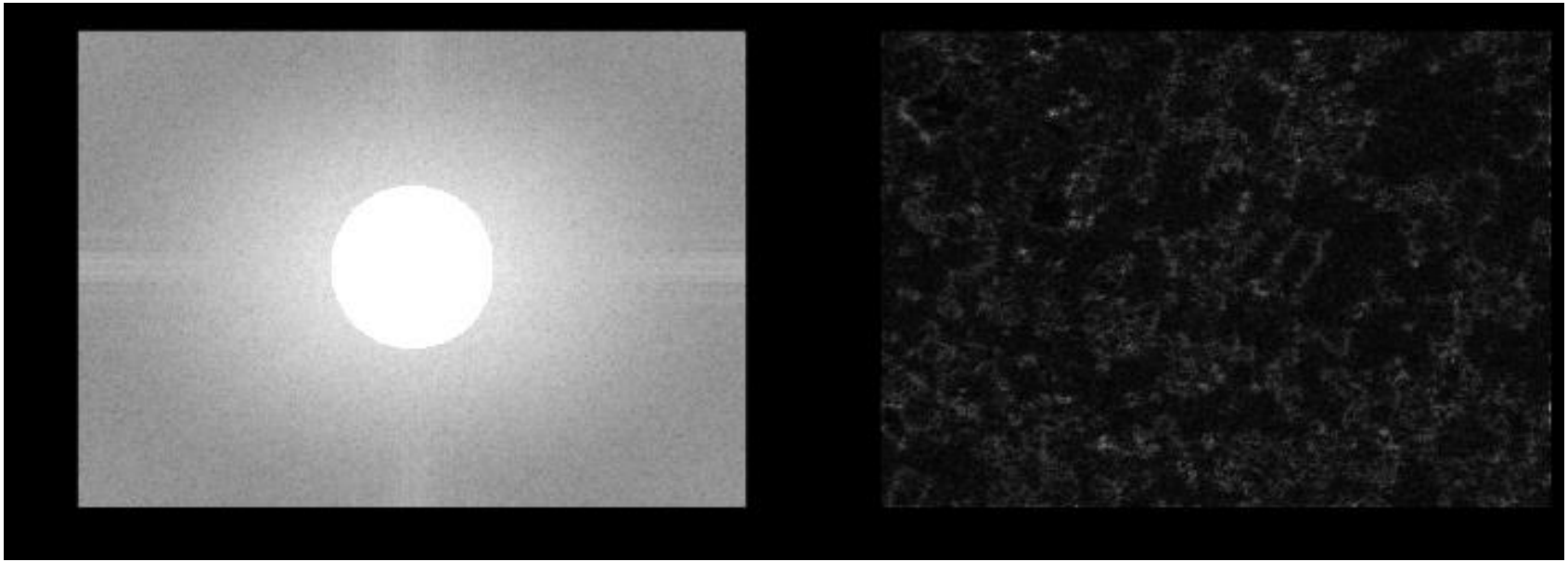

1 1 1 1 1
1 1 0 1 1
1 1 1 1 1
1 1 1 1 1

- Image in spatial domain
- FFT Image



- FFT image * mask
- Filtered image in spatial domain




THANK
YOU

Links to check

- https://dsp.stackexchange.com/questions/1637/what-does-frequency-domain-denote-in-case-of-images
- https://dsp.stackexchange.com/questions/6452/how-to-extract-high-frequency-and-low-frequency-component-using-bilateral-filter

- https://www.unioviedo.es/compnum/labs/PYTHON/lab06_Fourier2D.html