

COMS30030 – Image Processing and Computer Vision

Problem Sheet MM02

Fourier

1 – Which of the following fact(s) about the frequency domain is/are true?

- A. Moving away from the origin of transform the higher frequency components correspond to smooth graylevel variation.
- B. Moving away from the origin of transform the lower frequencies correspond to abrupt change in gray level values.
- C. frequencies within a specified range are bandlimited when the rest of the spectrum goes to zero.
- D. A, B & C are all TRUE.
- E. Only C is TRUE.

2 – How would low pass filtering be achieved using the Fourier domain? In your answer describe what is meant by Cut-off Frequency.

3 – Consider you are given the Fourier Transform space of an image. Using simple descriptions or sketches to illustrate your answer, how would you select relevant regions to extract spectral features from

- (a) only low frequency regions,
- (b) only the very high frequency regions corresponding to prominent variations in intensity in the image that are at around 45 degrees to the horizontal,
- (c) all approximately mid-range frequencies.

4 – Rotate an object, Fourier space rotates too. Translate an object, Fourier space translates too.

- A. Both statements are True.
- B. First statement is True and second one is False.
- C. First statement is False and the second one is True.
- D. Both statements are False.

5 – Consider how the Fourier domain of a signal is affected under the following operations:

(i) translation of an object within an image on a uniform background (ii) rotation of an object within an image on a uniform background.

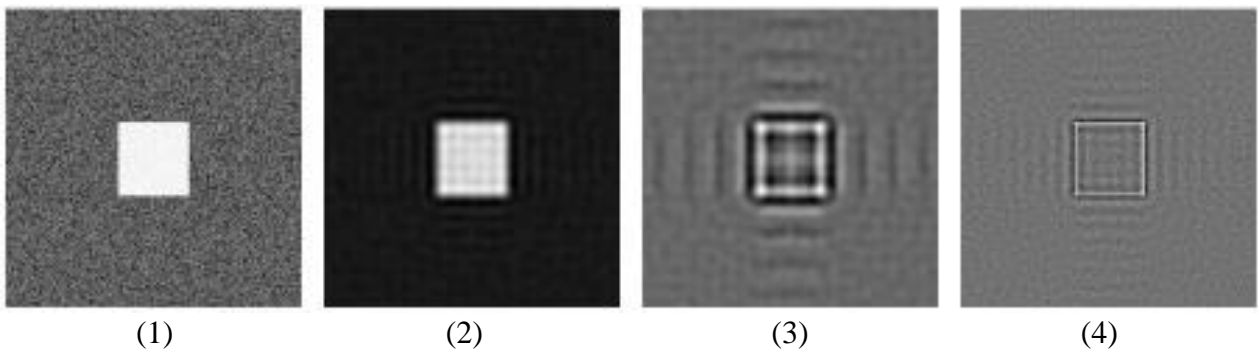
Which of these is TRUE:

- A. Under translation, the frequency magnitudes in the Fourier domain are shifted in a positive direction by the amount of translation. Under rotation, the Fourier domain magnitudes are rotated by an amount corresponding to the rotated object.
- B. Under translation, the Fourier domain is not affected and the frequency magnitudes retain their position. Under rotation, the Fourier domain magnitudes also remain in the same position.
- C. Under translation, the Fourier domain is not affected and the frequency magnitudes retain their position. Under rotation, the Fourier domain magnitudes are rotated by an amount corresponding to the rotated object.
- D. Under translation, the frequency magnitudes in the Fourier domain are shifted in a negative direction to the translation. Under rotation, the Fourier domain magnitudes remain the in the same position.
- E. None of the above are true.

6 – Here are images of three handwritten letters. Their Fourier spaces are randomly shown. Match each image with its own Fourier image.



7 – Given the four images (1) to (4) below, select from statements A to D the one which is CORRECT or, if all statements A to D are INCORRECT, select option E.

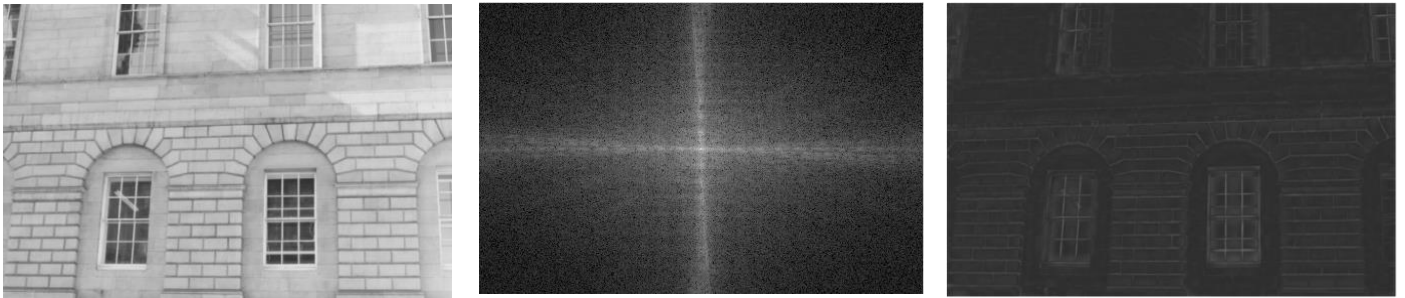


- A. Image (4) results from applying a lowpass filter to image (1).
- B. Image (3) results from applying a bandpass filter to image (1).
- C. Image (2) results from applying a highpass filter to image (1).
- D. Image (3) results from applying a highpass filter to image (1).
- E. All of the above are INCORRECT.

8 – Similar to the previous question, consider the two images (Sugar and Bricks) on the left. Identify which of the Fourier spaces (FS1 and FS2) on the right belongs to which image and explain briefly why.



9 – The figure below on the left shows an image of a building wall, with its Fourier Space magnitudes shown in the middle. A reconstructed image (inverse FFT image), after some manipulation of the Fourier magnitudes, is shown on the right. How should the Fourier space be manipulated (e.g., what kind of a mask could have been applied to it) to achieve this reconstructed result? Include a sketch to illustrate your answer.



10 – Which of the following statement(s) is true for the given fact that “Applying Highpass filters has an effect on the background of the output image”?

- (a) The average background intensity increases to near white
- (b) The average background intensity reduces to near black
- (c) The average background intensity changes to a value average of black and white
- (d) All of the mentioned
- (e) None of the mentioned

11 – The Butterworth lowpass filter has a parameter, filter order, determining its functionality as very sharp or very smooth filter function or an intermediate filter function. If the parameter value is very high, the filter approaches to which of the following filter(s)?

- (a) Ideal lowpass filter
- (b) Gaussian lowpass filter
- (c) All of the mentioned
- (d) A very customised filter
- (e) None of the mentioned