Brief Hints/Answers to Some of the Questions

1 Noise Reduction

(a) ... Which are the most important types of noise? ...

With respect to what?

- Its statistical properties: Gaussian, ...
- Its frequency content: white, ...
- Its coupling to the signal: additive, ...

... Can noise look like the signal?

Yes! And the signal can look like noise!! ...

(b) ... What is thresholding? ...

As a method of noise reduction! See heading of Question 1, and see the next point!!

... There is a very important difference between these two methods of noise reduction, a difference which affects the quality of the denoised image. ...

Smoothing always lowers the resolution of the image. Thresholding, if done appropriately, preserves the resolution of the image. ...

(c) ... Pollute this image with salt and pepper noise... (2)

Salt and pepper → white and black $\xrightarrow{\text{5-bit}}$ 31 and 0 (grey levels)...

... What is the (root-mean-square) signal-to-noise ratio of your noisy image?

$$SNR = \sqrt{\frac{\sum X_{ij}^2}{\sum (Y_{ij} - X_{ij})^2}}$$

$\{X_{ij}\}$ = original image

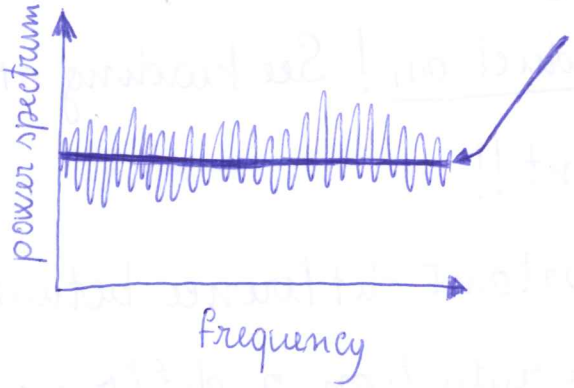
$\{Y_{ij}\}$ = your noisy image

Note: $\sum_{k=1}^{n} k^2 = \frac{n(n+1)(2n+1)}{6}$ ☺

2 Miscellanea

(a) It does not imply that the two images are the same, since nothing is stated about the Fourier phases...

(b)



<power spectrum> = constant

but power spectrum ≠ constant!

--- Are you really sure?

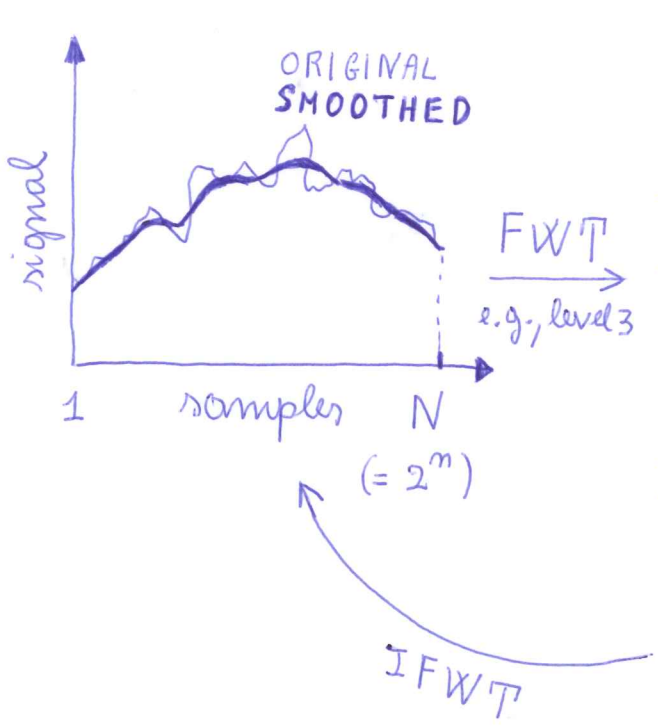
(In case you answer: power spectrum = constant)

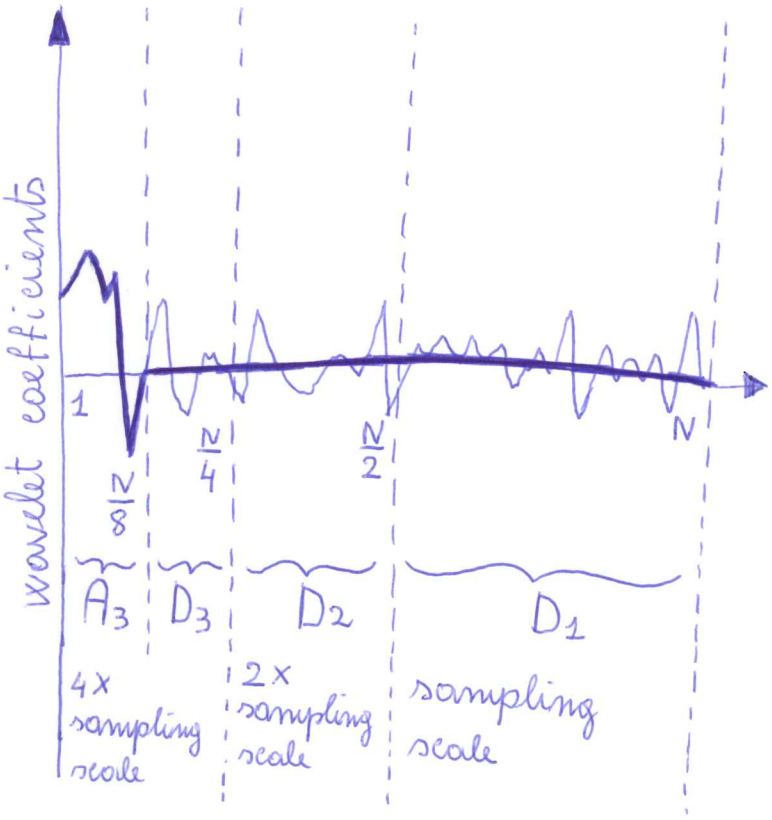
Reflect further:

- Sampling ---
- Truncation ---

(d)

smooth in wavelet domain = set the details to zero





- D_ℓ = details at $2^{\ell-1}$ × sampling scale →

How to **smooth** at resolution = 2^r × sampling scale:

* FWT at level $\ell = r+1$
* Set the detail coefficients to zero
* IFWT

(e) Similarly to (d):

How to **sharpen** at resolution = 2^r × sampling scale:

* FWT at level $\ell = r+1$
* Set the approximation coefficients to zero
* IFWT

How to **high-boost** at resolution = 2^r × sampling scale:

* FWT at level $\ell = r+1$
* Multiply the detail coefficients by a factor $f > 1$
* IFWT