NIT HAMIRPUR

MAJOR PROJECT

OUR TEAM

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APPLICATIONS OF WAVELET TRANSFORM

01 IMAGE FUSION

02 IMAGE COMPRESSION

03 IMAGE DENOISING

04 EEG AND ECG SIGNALS

- Breaking down input data into approximation and detail coefficients
- We perform different operations on these coefficients and reconstruct the output data by using operated coefficients .
- Approximation coeffficients act as low -pass filter
- Detail coeffficients act as high-pass filter

COEFFICIENTS

- All the coeffcients are of size M/2 x M/2 , if the size of original image was M x M
- Approximation coefficients act as smoothing filter
- Detail coefficients act as line and edge detectors
- 3 types of detail coeffceints exist : Horizontal , Vertical and Diagonal . All act as high pass filters as per their names

Common naming style for coefficients

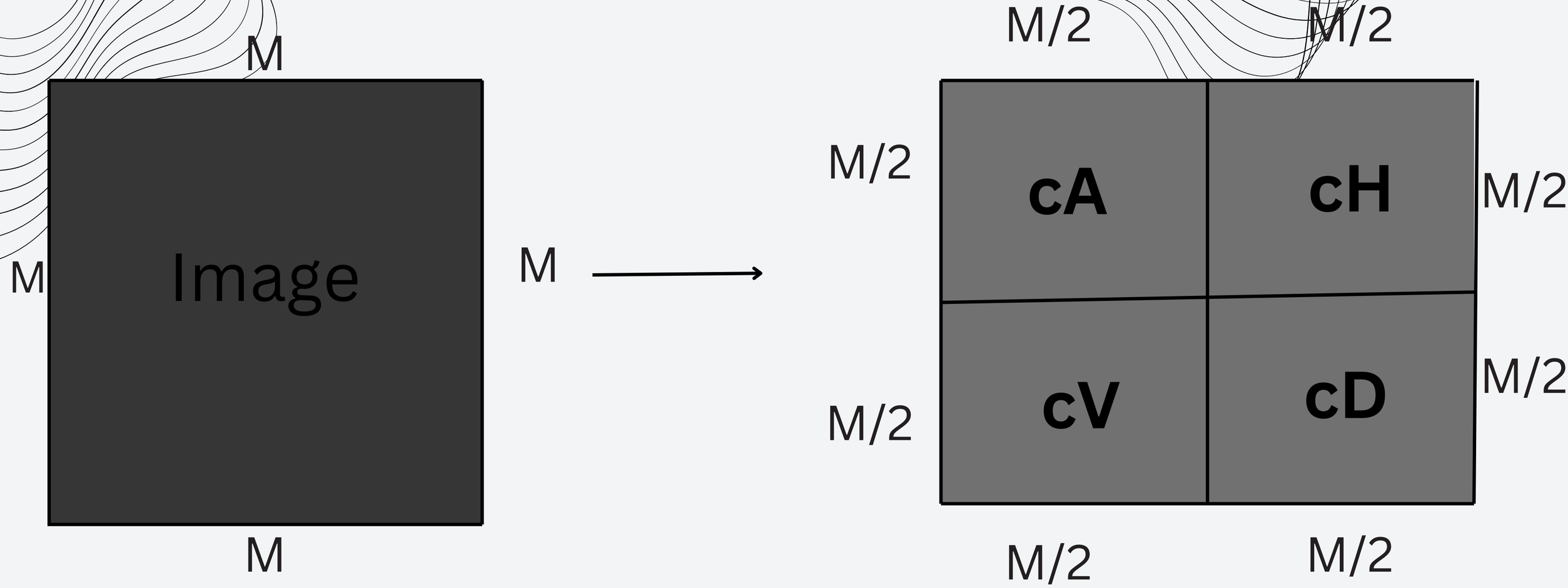
cA - Approximation coefficients

cV - Vertical coefficients

cH - Horizonatal coefficients

cD - Diagonal Coeffceints

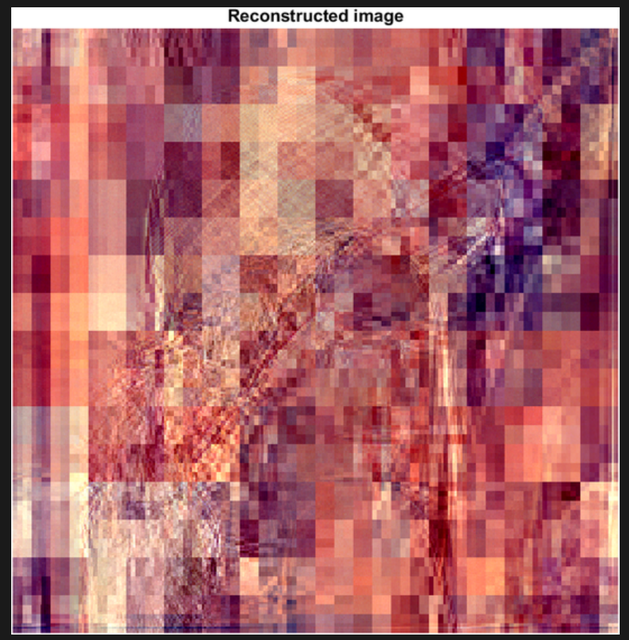
LEVEL 1 DECOMPOSITION



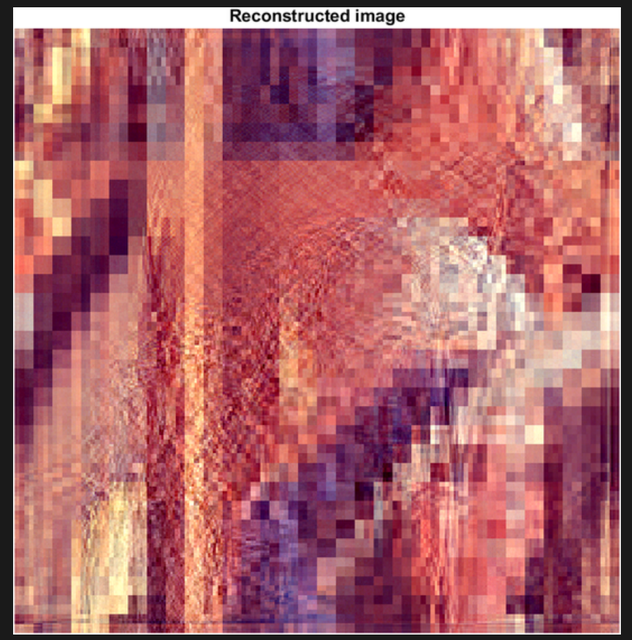
RESULTS

Haar wavlet (level 600)

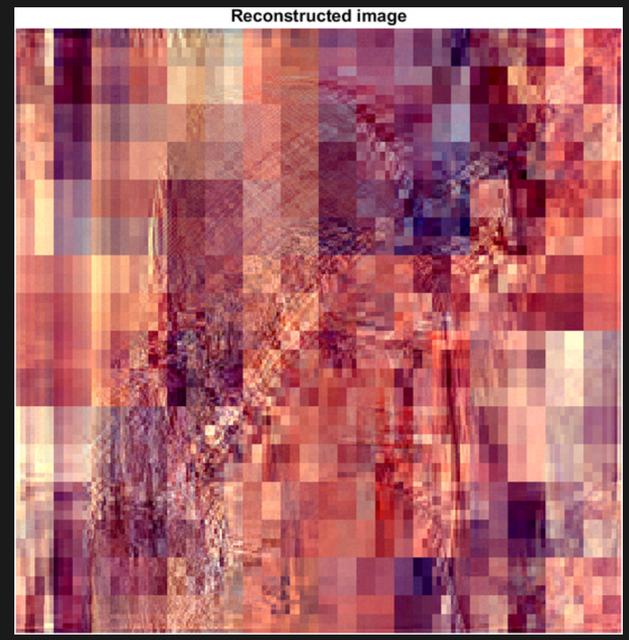
Coiflet wavlet (level 6)



Symlet wavelet (level 4)



Daubecius (level 5)



Haar Transform

Suppose we want to apply haar transform on vector $\begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix}$

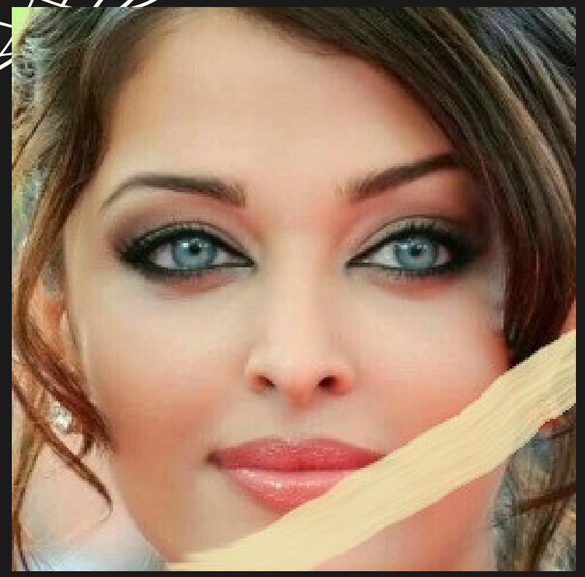
Haar Matrix

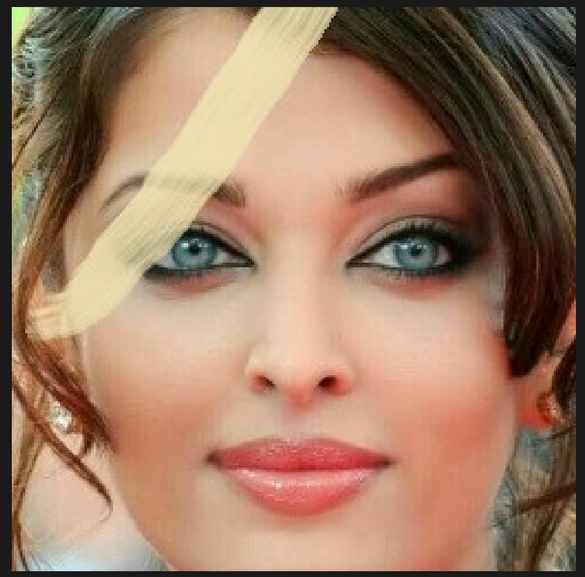
$$\frac{1}{2}\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & -1 & -1 \\ \sqrt{2} & -\sqrt{2} & 0 & 0 \\ 0 & 0 & \sqrt{2} & -\sqrt{2} \end{bmatrix}$$

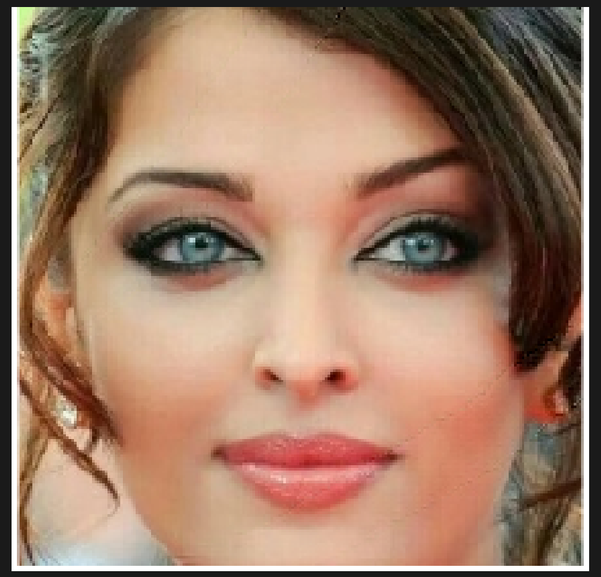
Inverse Haar Matrix

$$\frac{1}{2}\begin{bmatrix} 1 & 1 & \sqrt{2} & 0 \\ 1 & 1 & -\sqrt{2} & 0 \\ 1 & -1 & 0 & \sqrt{2} \\ 1 & -1 & 0 & -\sqrt{2} \end{bmatrix}$$

IMAGE FUSION

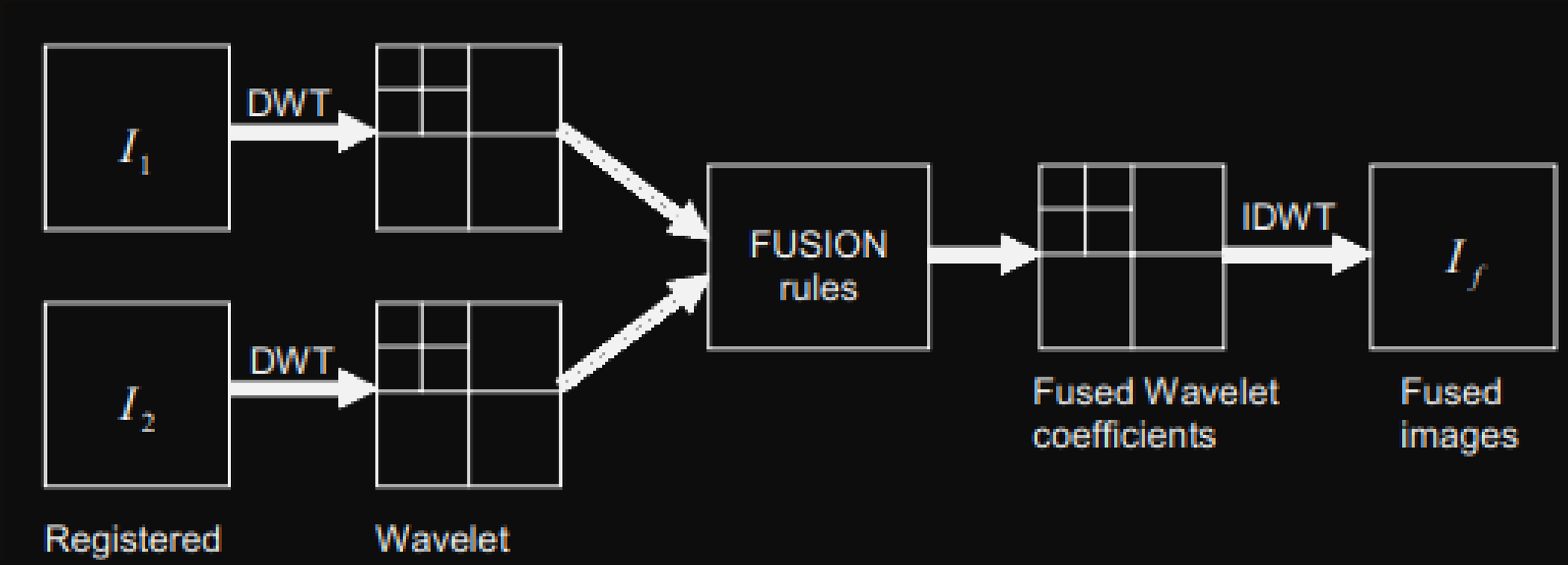






Procedure

Decomposition → Apply the min-max-mean method of fusion by Petrovic and Xydeas (2004) → Reconstruction



Fusion Rules

Image 1

cA1	cH1
cV1	cD1

Image2

cA2	cH2
cV2	cD2

Operation1 (cA1 , cA2)	Operation2 (cH1 , cH2)
Operation2 (cV1 , cV2)	Operation2 (cD1 , cD2)

RESULTS

MaxMax image

MinMax image

MinMin image

Image Compression

Lossless wavelet compression

- Data is lost but information is saved

- dwt and idwt functions applies thresholding due to upsampling and downsampling

- Thats why our image will be compressed if we deconstruct and reconstruct our image using these functions .

- For example : Approximation coefficients is created by downsampling (by 2) the orignal , once row wise and once column wise

Downsampling by 2

[1,2,3,4,5,6,7,8]

[1,3,5 ,7]

Upsampling by 2

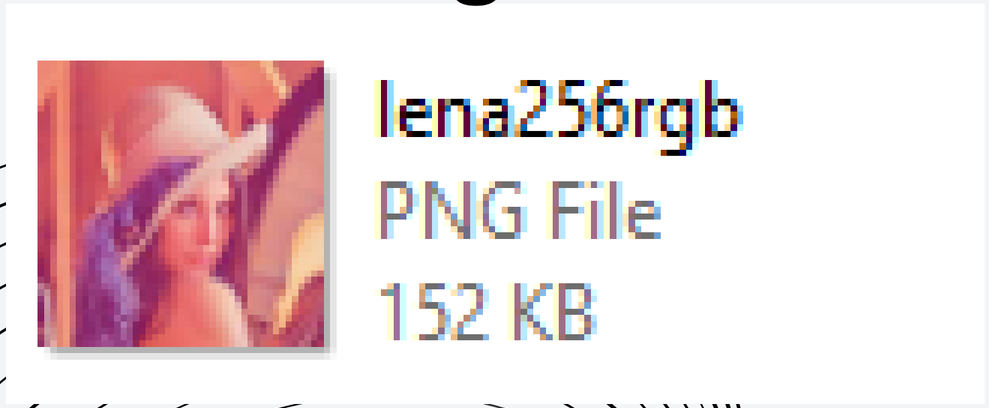
[1,3,5,7]

[1,0,3,0,5,0, 7]

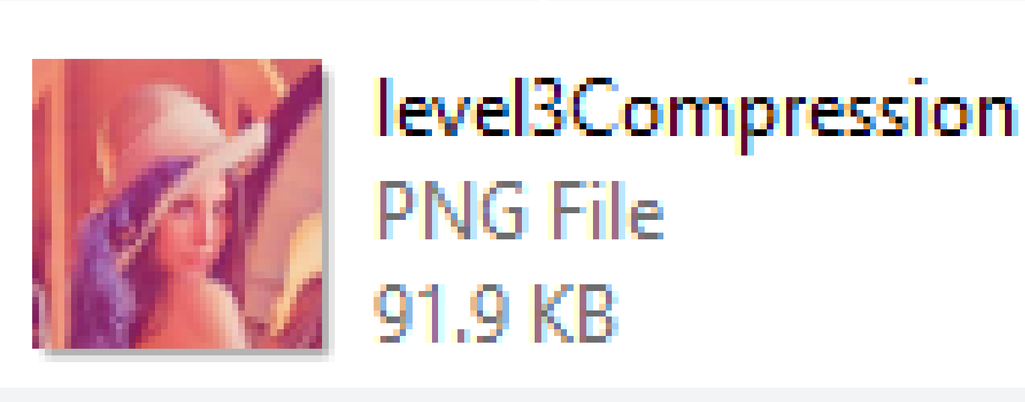
Result

Compression ratio : 1.65

original



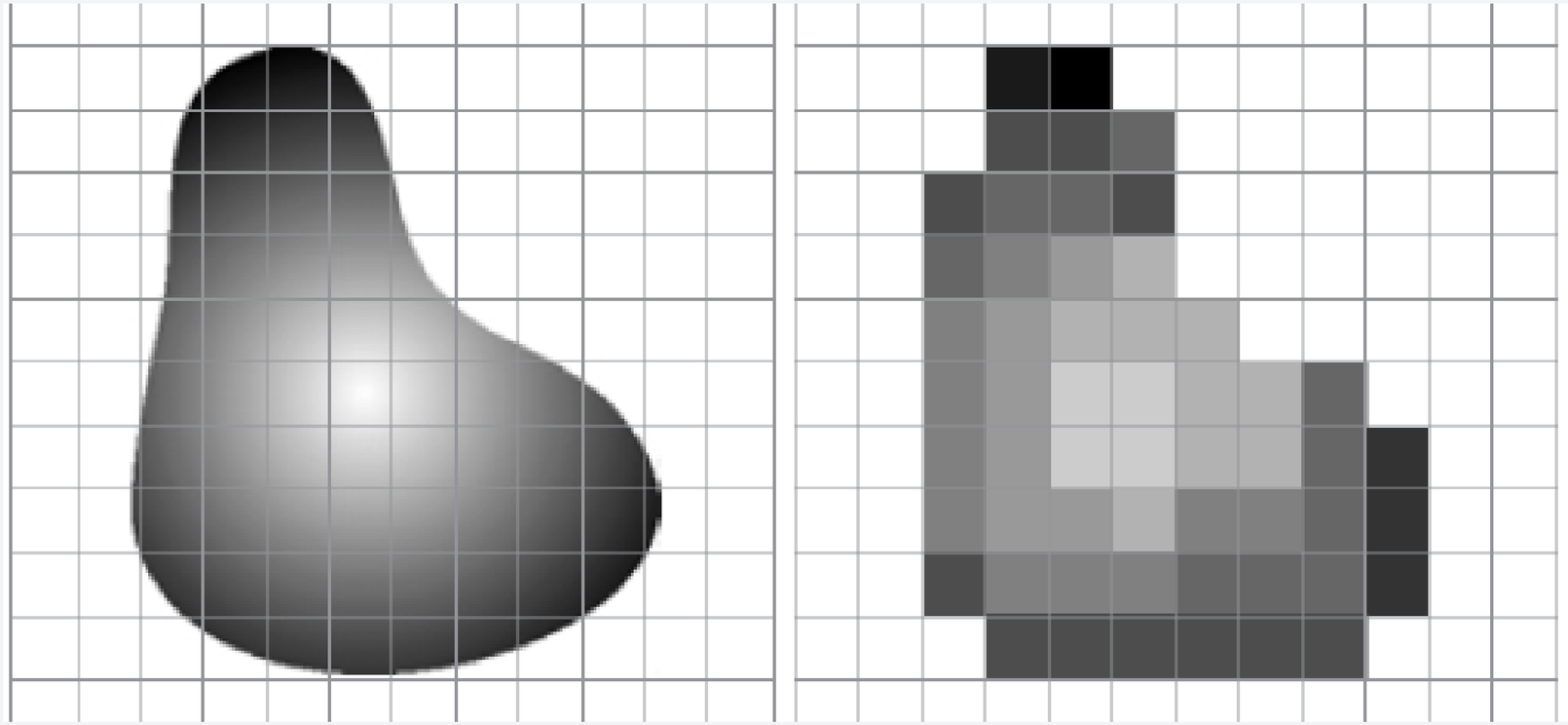
compressed



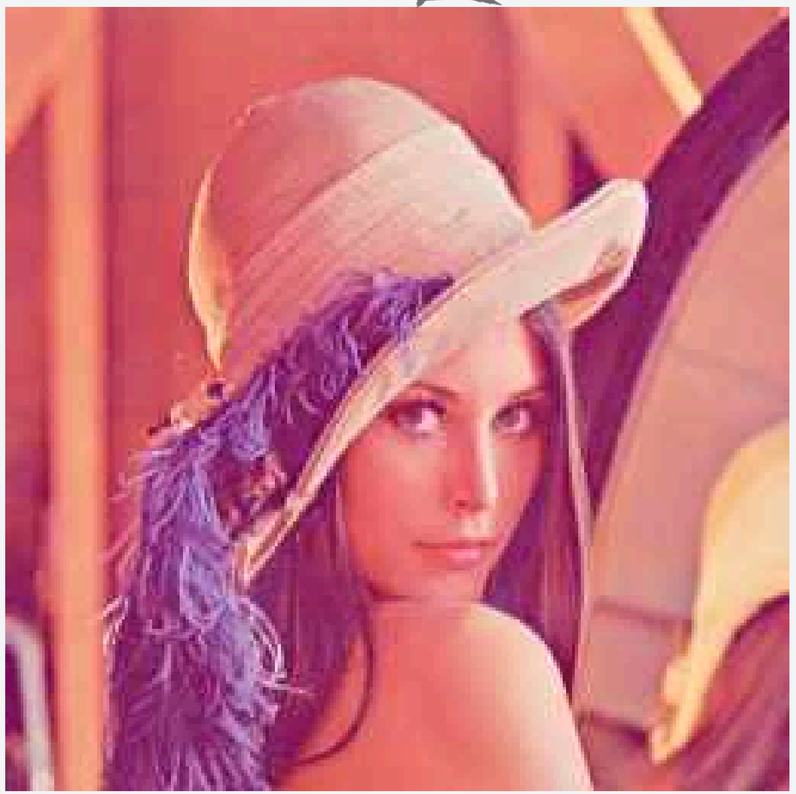
We apply quantization on all the coefficients

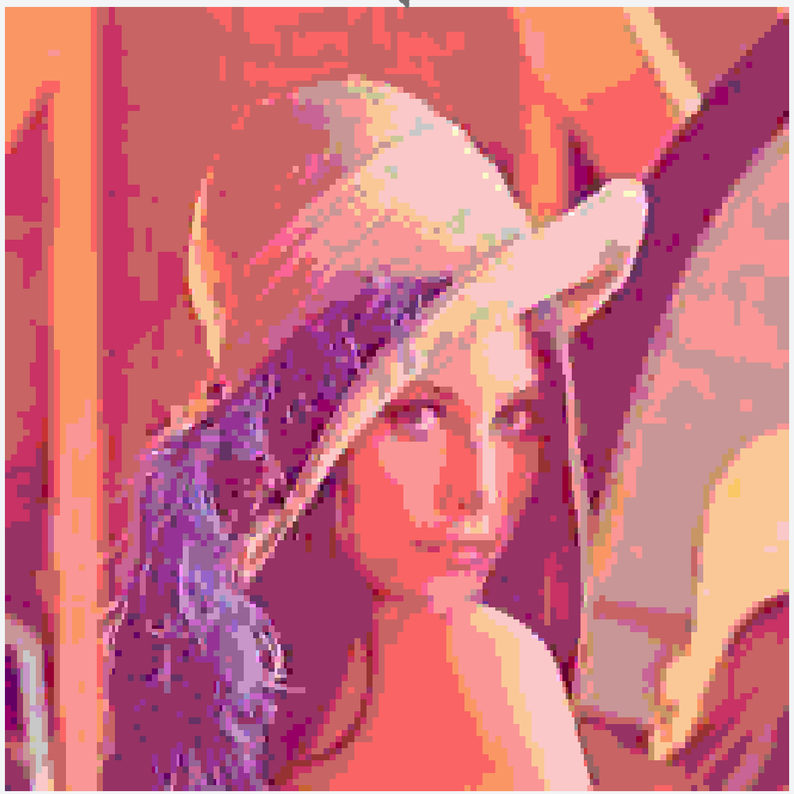
Quantization :

new = (round(old / quantization_step)) * quantization_step



Quantization step	**1**	**10**	**100**
Compression ratio	1.57	3.35	16.15





Quantization is applied on fast fourier transform

	Wavelet	Fast fourier
Compression ratio	8.88	8.88
Size	17.2 KB	17.2 KB

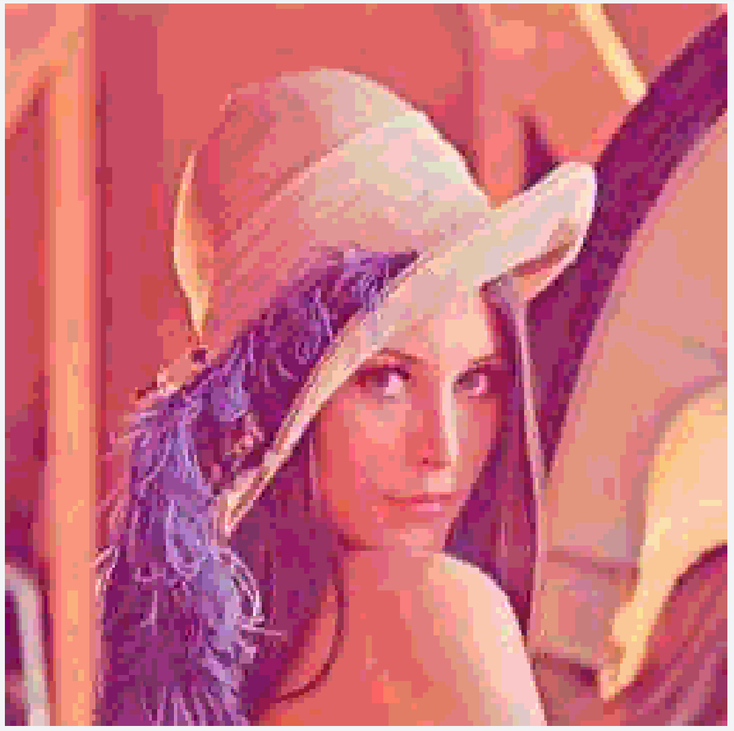
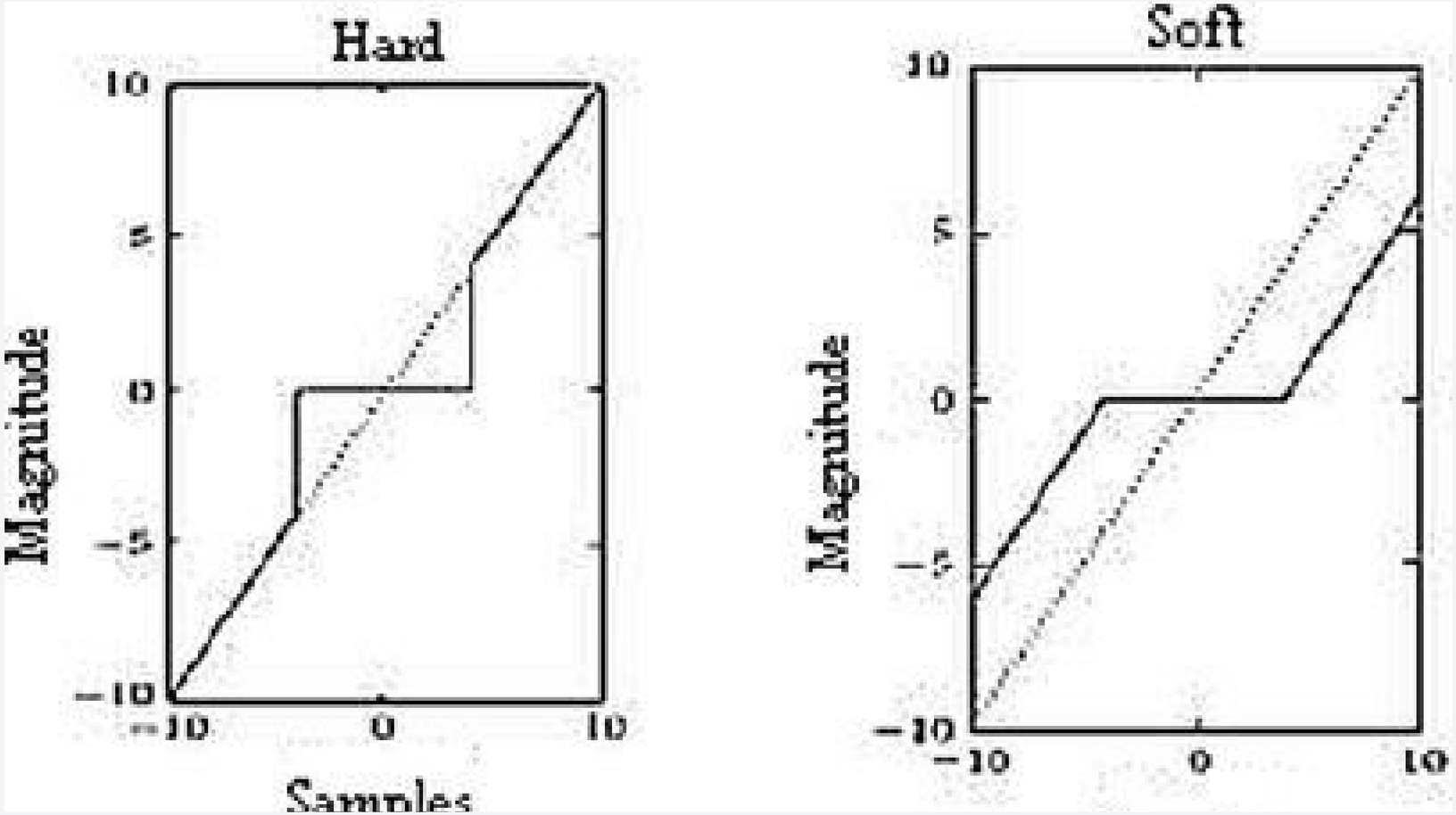


Image denoising

- Hard and Soft thresholding is applied to the coefficients



Results

- Size also decreses on thresholding

Soft Thresholding

Noisy Image (Added Gaussian Noise)

Hard Thresholding

EEG and ECG signal

- EEG - brain signal
- ECG - heart signal
- Continious wavelet transform will be used

THANK YOU