

Image Denoising and Compression using Wavelet

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Abstract

Denoising is one of an essential step to improve the image quality. In this project, image denoising is investigated. After reviewing standard image denoising methods as applied in the spatial, frequency and wavelet domains of the noisy image, the project embarks on the endeavor of developing and experimenting with new image denoising methods based wavelet transforms. Image denoising involves the manipulation of the image data to produce a visually high quality image. Finding efficient image denoising methods is still valid challenge in image processing. Wavelet denoising is an attempt to remove the noise present in the image while preserving the image characteristics, regardless of its frequency content. This project is intended to serve as an introduction to Wavelet processing through a set of Matlab experiments. These experiments will give an overview of three fundamental tasks in signal and image processing: approximation, denoising and compression.

Keywords – Image - denoising, Wavelets, Wavelet, Thresholding, Image Processing.

I. INTRODUCTION

A kind of signal processing where input is in the form of an image such as picture or frames which gives image or different parameters of an image as an output is called image processing. We can say that the image processing techniques involve treating the image in two dimensions and then applying standard signal processing methods or techniques. Due to different factors like environment defect in any electronic device capturing pictures, sensors, light level etc. The image gets corrupted and ample amount of noise gets added into the image during acquisition, transmission of image and interference of channels. So it is necessary to use image denoising techniques for the removal of random Gaussian noise such that the noise is fully suppressed and the important and key features of the original image is preserved. As image contains large information denoising should be done in such a way that the original content of the image is not

lost. The constituent elements of the image are pixels. A large number of bits are required to store and transmit the image. The speech signals are one dimensional while we are dealing with large image signals which are two dimensional. In any two dimensional bearing function $f(x,y)$ where x and y are spatial coordinates. If x, y and the amplitude values of f are all finite, discrete then the image is called digital image. Mainly three steps of image processing:-

- ❖ Linear forward wavelet transform
- ❖ Non-linear thresholding
- ❖ Linear inverse wavelet transform

The components of an image processing system are: -

- ❖ Image Acquisition
- ❖ Images Transforms
- ❖ Image Enhancement
- ❖ Image Compression

Image Acquisition : Digital image acquisition is the creation of the digital images such as of physical scene or of the interior structure of an object. The term is often assumed to imply or includes processing, compression, storage, printing and display of such images.

Images Transforms : Used to transform image into simple arithmetic operation on images or complex arithmetic operations. Mathematical operations include simple image arithmetic Fourier, fast Hartley transform, Hough transform and radon transform.

Image Enhancement : It is the process of adjusting digital images so that the results are more suitable for display or further image analysis.

Image Compression : It is minimizing the size in bytes of a graphics file without degrading the quality of the image to an unacceptable level. The reduction in file size allows more images to be stored in a given amount of disk on memory space. It also reduces the time required for images

to be send over the internet or downloaded from web pages.

II. INTRODUCTION TO WAVELET TRANSFORM

In image processing we can not directly deal with the image. first we have to transform the image into any other form which can be easily understood.for that there are few transform methods available.which are Fourier transform, Hilbert transform, Wavelet Transform.Fourier transform only gives frequency amplitude representation of the raw signal but can't give information about time.so time information lost.due to this Fourier transform can't be used where we need both Time and frequency information. Wavelet transform gives frequency representation of raw signal at any given interval time.Reason behind using wavelet is to study different signals at different resolutions which are known as multiresolution.wavelet also allows multiresolution decomposition which is important feature of it.due to its excellent property of localization it is widely used.and wavelet preserving the original signal while removing noise present in signal.which makes wavelets better than Fourier or any other transform.wavelet transform can be represent as:

$$C(\text{scale}, \text{position}) = \int_{-\infty}^{\infty} f(t)\psi(\text{scale}, \text{position}, t)dt$$

III. WAVELET THRESHOLDING

Wavelet thresholding is signal estimation technique that utilize the ability of wavelet transform for signal denoising.In simple it is a nonlinear technique which operates on the wavelet coefficient at a time.in thresholding noise can be removed by killing coefficients which are insignificant and relative to some threshold.threshold can be calculated using shrinkage techniques.mainly two types of thresholding are there Hard thresholding and Soft thresholding.

Thresholding technique is one of the best way of denoising using wavelets.In this project thresholding technique is used for image denoising.There are two kind of thresholding ie. Hard thresholding-edges are kept,but the noise wasn't fully suppressed and soft thresholding-edges aren't kept but the noise was almost fully suppressed.It is necessary to select perfect value of threshold for removal of noise from image as small threshold may result close to input but its result may be noisy & large threshold produce a signal with a large number of zero coefficients.Here are some methods which relay on the choice of threshold value:

- ❖ Universal Shrink
- ❖ Visu shrink
- ❖ Sure shrink
- ❖ Minimax shrink
- ❖ Bayes shrink
- ❖ Normal shrink

BLOCK DIAGRAM

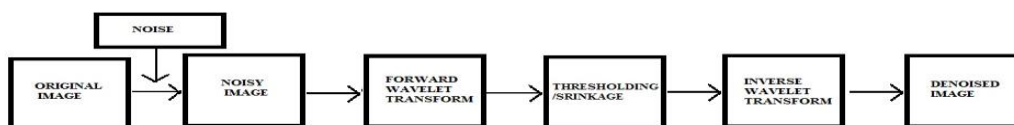


Fig. 1 Image denoising block diagram

IV. COMPARISON

A. Hard Thresholding

To suppress the noise we apply the following nonlinear transform to the empirical wavelet coefficients:

$$F(x) = x \cdot I(|x| > t)$$

where t is a certain threshold. The choice of the threshold is a very delicate and important statistical problem. On the one hand, a big threshold leads to a large bias of the estimator. But on the other hand, a small threshold increases the variance of the smoother. Theoretical considerations yield the following value of the threshold:

$$t = \sqrt{2\sigma^2 \log(n)/n},$$

where n is the length of the input vector and σ^2 is the variance of the noise. The variance of the noise is estimated based on the data. We do this by averaging the squares of the empirical wavelet coefficients at the highest resolution scale. We provide two possibilities for choosing a threshold. First of all you can do it by "eye" using the *Hard threshold* item and entering the desired value of the threshold. The threshold offered is the one described in the paragraph before. Note that this threshold value is in most cases conservative and therefore we should choose a threshold value below the offered one. The item *Automatic* means that the threshold will be chosen

$$\sqrt{2\sigma^2 \log(n)/n}$$

as with a suitably estimated variance.

B. Soft Thresholding

Along with hard thresholding in many statistical applications soft thresholding procedures are often used. In this section, we study the so-called wavelet shrinkage procedure for recovering the regression function from noisy data. The only difference between the hard and the soft thresholding procedures is in the choice of the nonlinear transform on the empirical wavelet coefficients. For soft thresholding the following nonlinear transform is used:

$$S(x) = \text{sign}(x)(|x| - t)I(|x| > t),$$

where t is a threshold. The menu provides you with all possibilities for choosing the threshold and exploring the data.

Matlab program steps for hard and soft thresholding comparison:

- ❖ Generate signal and set threshold.
- ❖ Perform hard thresholding.
- ❖ Perform soft thresholding.
- ❖ Using some plotting commands,
- ❖ the following figure is generated.

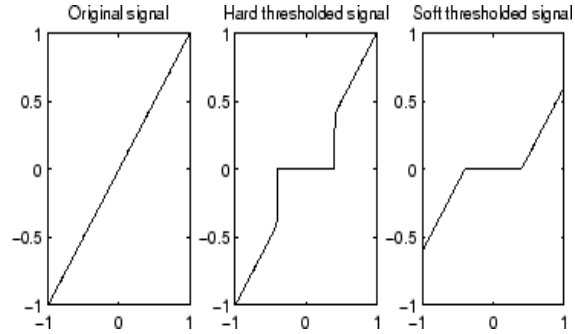


Fig. 3 hard vs soft thresholding

V. IMAGE DECOMPOSITION

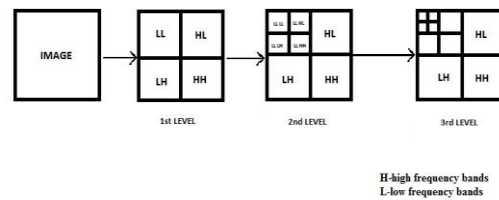


Fig. 2 Image decomposition

VI. IMAGE DENOISING

An image often corrupted by noise in its transmission or compression. so image denoising is to remove additive noise from the image and get the output image as much noise free as possible. In signal small coefficients are due to noise and large coefficients are mainly due to signal. so by using wavelet and thresholding technique we can threshold small coefficients and get our image noise free. because wavelet provides an appropriate basis for separating noisy signal from the main signal.

Steps of image denoising:

- ❖ Image
- ❖ Addition of noise
- ❖ Wavelet transform
- ❖ thresholding
- ❖ Filtering
- ❖ Image reconstruction
- ❖ Denoised image

VII. CONCLUSION

We have used wavelet toolbox specially for wavelet in two dimensions in matlab using step by

step for image denoising and compression. This paper serves the whole idea behind denoising of an image using different methods and set of matlab program and operations performed step by step. After performing these steps we get noiseless image and the contents of the image is also preserved. Matlab codes for different types of operations like denoising, decomposition, compression etc. can be generated.

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