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A Survey on Image Denoising in Wavelet Domain

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***Abstract*—*X-rays has a special characteristic of electromagnetic radiation. The theory behind the production of X-rays beam is straightforward. When X-rays pass through the human body, some of these rays are absorbed by the body. This phenomenon of absorption is known as attenuation of X-rays. The attenuated X-rays are absorbed by the detectors that are on the opposite side of the body. This leads to the production of X-ray image. Medical X-rays also have different important features. Due to these features, medical X-rays are of great significance. In most cases the addition of noise in images occurs during the process of image acquisition and during the transmission process. So there is great need of removal of noise. Image de-noising is hence required. In most cases the addition of noise in images occurs during the process of image acquisition and the transmission process. Image de-noising is used to remove the additional noise that is actually available in the image.*

Keywords: Harris operator; Noisy pixels; Poisson noise; Wavelet domain; X-rays.

1.INTRODUCTION

The generation of X-rays takes place in vacuum tubes. When a metal target is bombard with high speed electrons, the generation of X-rays takes place. During this process radiations are produced. When these radiations are passed through the body of patients, production of images takes place. A radiograph of this process is generated with the help of digital recorder. X-rays have a special characteristic of electromagnetic radiation. The theory behind the production of X-rays beam is straightforward. When X-rays pass through the human body, some of these rays are absorbed by the body. This phenomenon of absorption is known as attenuation of X-rays. The attenuated X-rays are absorbed by the detectors that are on the opposite side of the body. This leads to the production of X-ray image. Medical X-rays also have different important features. Due to these features medical X-rays are of great significance. The main purpose of image de-noising should be attainment of useful information as much as possible. In this paper, a survey has been conducted on the wavelet techniques as wavelet provides an appropriate criteria to separate the noisy image from the original image.

2.LITERATURE SURVEY

Thakur et.al.[1] proposed a method in which X-rays along with the photon are used to generate X-ray images. The X-rays used for this purpose should have wavelength below 0.2 to 0.1nm. These X-rays have the high penetration ability. But these rays generally consists of photon i.e. these rays obeys the distribution of Poisson noise. This Poisson noise effects the quality of medical images. In this paper, Harris operator in modified form as well as wavelet domain based thresholding is suggested to do de-noising. Harris Operator has the advantage that it finds the pixels in the image where intensity is high to give the better results.

Zhang et.al.[2] proposed a system which uses the linear minimum mean square error calculation for the process of de-noising. It assures good output of the image. During the acquisition of the image, noise may present system. When de-noising gets completed, this image is required for the interpolation process. During the application of interpolation scheme of de-noising, sometimes image's detail along the edges gets effected. Thus the interpolation scheme may introduce artifacts in the image. The crucial issue in the interpolation scheme is thus preservation of edges. To remove these problems, a scheme named as Directional Interpolation Scheme is introduced. Therefore a directional de-noising algorithm is suggested. It includes a scheme named directional interpolation . The calculation of noiseless and missing samples is conducted using the optimal calculation for the same framework. This estimation process is carried out by using adaptive calculation of various local statistics. By using this calculation a better or accurate output is obtained in many

directions. This method not only preserves the image edge structures but also decreases the artifacts introduced in the image.

Jung *et.al.*[3] proposed that two complementary discontinuity measures are used in the scheme of Bayesian Image De-noising. But the spatial discontinuity has a special characteristics of over-locality. Due to this over locality characteristic, many crucial discontinuities can not be detected during the process of de-noising. However spatial discontinuity has a feature that it preserves the image's edge components in a better way. Therefore, there is great need of finding new discontinuity measures for the purpose of preservation of features by following the detection process of contextual discontinuities. discontinuities. The main advantage of this scheme is that in the small regions there is degree of uniformity. Also there is effective detection of crucial discontinuities in this method. The prior probabilities of de-noising scheme of Bayesian framework are created by using the combined complementary discontinuity measures. This method achieves high PSNR, also the edge components are preserved well.

Chen et.al.[4] proposed that for the de-noising process , three scales of dual tree complex wavelet coefficients are used. This is done for the removal of a specific noise. This noise is known as White Gaussian Noise. Dual tree complex wavelet transform have special characteristic of approximate shift invariance and better directional selectivity. Due to these two special qualities it provides high competitive outputs. In case of 3D MRI(magnetic resonance images) , there exists other useful methods. This technique is based on the idea of block wise non-local(NL) means scheme. This NL means scheme is used along with adaptive multi resolution. In the adaptive soft wavelet coefficient mixing, the content of de-noising is implicitly adapted with respect to the spatial and frequency based contents.

Coupe *et.al.*[5] proposed a filter which is suitable for mainly two types of noises. These noises are basically Gaussian Noise and Rician Noise. When this technique is compared to the other latest techniques like Rician NL means filter technique produces high competitive measure results with the help of several quality metrices on brain web databases in the quantitative validation. This type of filter not only preserves the fine details but also removes the noise. This filter actually does experiments on the images like anatomical and diffusion weighted MR images. This is generally used in the area of fiber tracking. Authors have proposed an improved decision based detail preserving variational method to remove a special type of noise. This Type of noise is basically random valued impulse noise. A great care is needed if the images are highly corrupted. So in case of highly corrupted images, it is very important to improve the detection process. To achieve this, a variable window scheme is introduced which is employed by adaptive centre weighted median filter. While the classification of noisy parts of the image is carried out then various noise marks are labeled. This is carried out by fast iterative strategy given by improved ACWMF. To store all the noisy parts of the image a weight adjustable detail-preserving variational method is purposed. Also all these noisy parts of the image are stored as one time event. The function of these noise marks is that it decides the weights of DPVM's convex cost function. This_decision is done on the basis of data fidelity term and smooth regularization term. After the minimization process, this restored image is fetched. The quantitative measurements and version done by the proposed filter outperforms all other existing algorithms. It is quite fast and easily it can be used for practical applications or can say in real time applications.

Zhou *et.al.*[6] discussed many noise models according to the form of images. Mostly the images can be of the form real, satellite, medical images etc. The decomposition process is presented in form of new model. In the new proposed algorithm a non-convex, non-smooth regularization and also Hilter Sobolev spaces whose degree is negative in differentiability are applied. This captures the oscillatory patterns. A pseudo solution which is already proven exists for the proposed model. To solve the minimization problem, variable splitting and penalty schemes are used. This problem is solved by using different numerical algorithm. Many experiments are carried out for the de-noising, de-blurring and decomposition for the real and synthetic images.

Lu. C.W[7] discussed the main issue in digital image processing is to reduce the noise in the various images. With respect to the various experiments, assumptions, applications, limitations, various image de-noising algorithms have been proposed.

3.TECHNIQUES USED FOR IMAGE DENOISING IN WAVELET DOMAIN

Images are usually corrupted by noise. Noise is nothing but an unwanted signal that effects the image. This noise or the unwanted signal degrades the quality of the image. Generally noise effects the image during the retrieval of the image. This added noise is the main cause of bad results when process is carried out. Hence the performance is badly affected due to this unwanted noise factor. For the removal of noise, various noise removal

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techniques are used. The main goal of noise removal techniques is to preserve the important information. The amount of preservation of this important or usual information should be as much as possible.

3.1IMAGE DE-NOISING USING HARRIS OPERATOR

Image de-noising using Harris Operator is an important technique of de-noising. Harris Operator is also known as Harris Gradient Detector. Harris Operator is also used in Watermarking. A image usually consists of three main regions. These reasons are flat region, edge and corner. In flat region the value of intensity does not change at all. In case of edge based region, the value of intensity does not change along the direction of edges basically. In corner based region there is change of intensity along each and every direction. Basically corner is intersection of two edges in its most basic form. The definition of edge can be stated in terms of image brightness. Thus edge is a point in which quick change in image brightness takes place. An important property of Harris Operator is that it has rotation invariant property, hence it achieves approximate scale of particular operation.

Harris Detector calculation:

Intensity variation for the shift value $[u, v]$:

$$E(u,v)\sum_{x,y} W(x,y)[I(x+u,y+v) - I(x,y)]^2 \quad (1)$$

Here $W(x,y)$is window function,$I(x+u,y+v)$ is shifted intensity and $I(x,y)$is Intensity.If the requirement is constant patches , the value of shifted intensity minus original image intensity needs to be near 0. If the requirement is distinct patches, then the value of shifted intensity minus original image intensity needs to be large. So the conclusion of Harris Operator calculation is that the value of $E(u,v)$ should be large i.e. the requirement of patches will lies in the area where $E(u,v)$ is large.

Also the wavelet function is:

$$\varphi(x) = \sqrt{2}\sum_k h(k)\,(2x-k) \quad (2)$$

$$\varphi(x) = \sqrt{2}\sum_h h(k)\,\varphi(2x-k) \quad (3)$$

The scaling function in wavelet :

$$G(k) = (-)^k h(1-k) \quad (4)$$

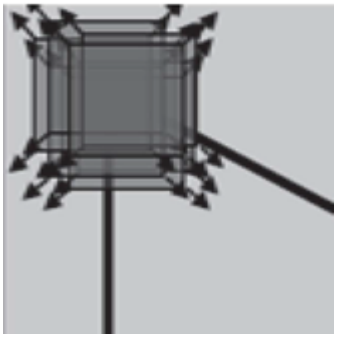

FIGURE1:coner point detection

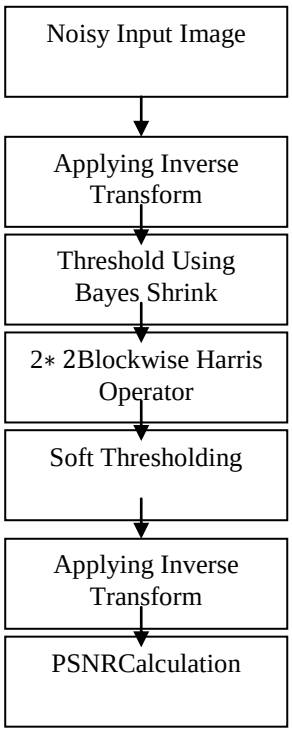

Figure 1: Flow Chart of Harris Operator based scheme

Advantages of using Harris Operator based de-noising

- Well efficiently detects corner points**.**
- Consists gradient operation which has the benefit of achieving approximate scale.
-
- Achieves rotation invariant property.

Disadvantages

- Does not significantly preserve the edge details.

3.2IMAGE DE-NOISING USING DIRECTIONAL INTERPOLATION SCHEME

From the past research it has been concluded the some techniques of directional interpolation scheme makes a

consideration that the image is noise free in certain cases. But this consideration is not possible in practical life, as the possibility of noise free image is not possible. Image interpolation scheme first of all removes the noise present in the image and then it follows the Interpolation process. During the application of interpolation scheme of de-noising, sometimes image's detail along the edge gets effected. Thus the interpolation scheme may introduce artifacts in the image. The crucial issue in the interpolation scheme is thus preservation of edges. To remove these problems, a scheme named as Directional Interpolation Scheme is nominated. For the de-noising process, the estimation process of the Directional Interpolation scheme will interpolate the missing samples of the image.

Advantages of using Directional Interpolation Technique

- Finds the details along the edge structures those were avoided in Harris Operation based de-noising technique.
- Directional Interpolation Scheme does not assume that the image is already noise free unlike other Interpolations schemes.

Disadvantages

- Does not efficiently preserve all edge details of the image.

3.3BAYESIAN IMAGE DE-NOISING TECHNIQUE

Bayesian scheme of made de-noising involves calculation of two complementary discontinuity measures. Among these, the first discontinuity measure is the spatial-gradient which is used for the purpose of discontinuity measure. The main feature of this spatial-gradient is that it preserve the edge components of the image effectively. The second discontinuity measure is used to find the contextual discontinuities.

***Advantages* of directional interpolation technique**

- The discontinuity measures used in this scheme provides degree of uniformity in small regions of image.
- Detects the location of discontinuity in much better way.
- Achieves high PSNR.

4.COMPARISION TABLE FOR DE-NOISING TECHNIQUES

Ref. no.	Technique	Purpose	Conclusions
1.	Harris Operator	Finds intensity variation of corner points	Produces a de-noised image
2.	Directional Interpolation Technique	To finds avoiding edge structures	Produces visually pleasing enlarged image
3.	Bayesian Interpolation Technique	To reduce noise and reconstruct original image	Preserves edge components as well as achieves high PSNR

TABLE 1 Compare by Performance

5.CONCLUSION

In this paper, survey on de-noising in the digital images have been conducted. This survey is conducted with the help of different techniques that are used for image de-noising. In these techniques various methods of de-noising are well stated. Performance results shows that where in Harris Operator based de-noising scheme well efficiently finds the corner points for de-noising purpose. On the hand, Directional Interpolation Scheme finds the details along the edge structures those were not covered by the technique of Harris Operator. While the Bayesian Image De-noising technique not only achieves the high PSNR but also preserve the edge components of the image.

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