IMAGE DENOISING USING VARIOUS TECHNIQUES: A SURVEY

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Abstract: 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 affects the image during the retrieval of the image. This added noise is the main cause of bad performance while performing any computation. Therefore the performance is badly affected due to this unwanted noise factor. For the removal of noise, various noise removal 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. The work presented here reviews few such methods presented earlier in an effort to efficiently reduce the noise in images

I. INTRODUCTION

A main step in image processing is the step of removing various kinds of noise from the image. Sources of noise in an image mostly occur during storage, transmission and acquisition of the image. When the undesirable signal termed as noise, then the original image will degrade which reduces the quality of image.in the past decades, many researchers proposed various algorithm. Most of the algorithms can be classified into two major categories: spatial domain and transform domain filtering. Operations that are performed directly on the image known as spatial domain filtering, whereas operations performed on transform domain of the image constitute transform domain filtering.Two types of spatial domain filtering is present, a) Linear and b) Non-Linear filters.

In most cases the addition of noise in images occurs during the acquisition and during the transmission process. So there is great need of removal of noise. Image de-noising is hence required. Image de-noising is used to remove the additional noise that is present in the image. The main goal of image de-noising should be attainment of useful information as much as possible.

Noise is nothing but an unwanted signal that affects the image. This noise or the unwanted signal degrades the quality of the image. Generally noise affects the image during the retrieval of the image. This added noise is the main cause of bad performance while performing any computation. Therefore the performance is badly affected due to this unwanted noise factor. For the removal of noise, various noise removal 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. There are two main forms in which noise can be present:- Additive form And Multiplicative form.

In the additive from, if the nature of the noise is additive and it is present in the original image, it will produce a corrupted noisy image. Additive Noise Model will satisfy the following equation:-

$$w(x,y) = s(x,y) + n(x,y) \qquad (1)$$

Here, s(x, y) is the original image intensity and n(x, y) indicates the added noise to produce the corrupted signal w(x, y) at (x, y) pixel location.

In multiplicative form, an important property is that the noisy signal gets multiplied to the original signal. It will obey the following rule:-

$$w(x,y) = s(x,y) + n(x,y) \qquad (2)$$

Here, s(x, y) is the original image intensity and n(x, y) indicates the added noise to produce the corrupted signal w(x, y) at (x, y) pixel location. The main limitations of image accuracy are its Blurness and Noise. Roughly noise can be represented as:-

$$v(i) = u(i) + n(i) \qquad (3)$$

Where i ∈I, v(i) is the observed value at pixel position i,n(i) is additional noise present in the image.

Noise is introduced to the image during the transmission process. Noise may also add to the image during the image acquisition process. The quantification of the image is represented by the factor how much pixels are corrupted in the image. Environment factors can also be the main reason of noise. So it is also a major source of noise. Environment conditions includes generally rain, snow etc.

II. RELATED WORK

Cai et.al.[1] proposed a image restoration process in which sparsity based regularization methods makes the assumption that the image has a good sparse approximation under a certain system. The type of the system can be a basis, a frame or it can be image restoration. One widely used system is wavelet tight frames. There have been a lot of efforts on seeking wavelet tight frames in which a certain class of functions or images can have a good sparse approximation. Yet, there is possibility that these structures can vary greatly in practical applications. Also, there is possibility of malfunctioning of this system i.e. the system that works for one kind of images may not work for the other type of images. This paper represents a method that defines a discrete tight frame system from the original input image to give a better sparse approximation to the original image or can say to the input image. This type of adaptive tight frame construction technique is applied to the image de-noising. This constructs a tight from tailored to the given noisy data. The results of experiments shows improvement in the other wavelet tight frames designed for the class of images. In the proposed method, it is assured that the resulted system is always a tight frame .Also it runs faster than the other over-complete dictionary based approaches in comparison to other de-noising techniques.

Talebiand Milanfar et.al.[2]proposed that mostly existing de-noising algorithms are generally based on exploiting similarity between a relatively modest number of patches. These methods of patch based scheme are strictly dependent on patch matching criteria and their performance is hamstrung by the ability to reliably find sufficiently similar patches. As the number of patches grows, a point of diminishing returns is reached in which the improvement of performance is due to more patches and it is offset by the lower probability of finding sufficiently close matches. The net effect is that while patching based methods, such as BM3D, are excellent overall, they are limited in how well they can do on the larger images with increasing complexity. This paper addresses these limitations by constructing a paradigm for truly global filtering in which every pixel is estimated from all the pixels in the image. The objectives stated in this paper are twofold. Firstly, a statistical analysis of proposed global filter is given which is based on a spectral decomposition of its corresponding operator. Also the study of effect of truncation of this spectral decomposition is carried out. Secondly, an approximation to the spectral i.e. principal components using the Nyström extension is driven. Using these, it is demonstrated that this global filter can be implemented efficiently by sampling of pixels. This sampling is done on a fairly small percentage of the pixels in the image.

Gu et.al.[3] proposed that from the recent years, there has been a wide research on the nuclear norm minimization as a convex relaxation of the low rank nuclear factorization problems. The nuclear norm minimization that is in standard form regularizes each singular value equally to continue the convexity of the objective function. But due to this, it greatly restricts its capability as well as flexibility while dealing with many other practical problems i.e. For denoising. In practical applications, singular values have clear physical meanings. So these should be treated differently. In this paper, the study of WNNM (Weighted Nuclear Norm Minimization) is carried out, where the singular values are assigned the distinct weights. Also the solution of these WNNM based problems are analysed under the different weighting conditions. Then the application of proposed WNNM algorithm is applied to the image denoising by exploiting the image non local self-similarity. Experiment results shows that the proposed strategy can effectively globalize the existing de-noising filters for the purpose of estimation of each pixel by using all the pixels in the image. So it is an improvement over the best patch-based methods.

Burger et.al.[4]proposed that image de-noising can be explained as a problem of mapping . This mapping is usually from a noisy image to a noise-free image. Currently available techniques that are best enough approximate this mapping with other cleverly engineered algorithms. In this paper, an attempt of learning the mapping directly with a plain multi layer perceptron (MLP) is applied to the image patches. Yet this has been done before, this paper shows that the training on the large image databases are able to compete with the current state-of-the-art image denoising methods. Further, the proposed approach is easily adapted to less extensively studied types of noises by just changing the training data to achieve the excellent results.

Bhandari et.al.[5] proposed different wavelet filters by using improved sub-band adaptive thresholding function for the purpose of denoising in case of satellite images based on the evolutionary algorithms. In this method, the techniques are based on the stochastic global optimization method. So the main techniques ABC, CS, PSO, where ABC denotes the Artificial Bee Colony, CS is Cuckoo Search, PSO is Particle Swam Optimization are used to obtain the parameters of adaptive thresholding function that is required for optimum performance. The visual and quantitative results clearly shows the increased efficiency and flexibility of the proposed CS algorithm which is based on the Meyer wavelet filter when compared to the other wavelet filers for the purpose of de-noising. From the analysis study of various techniques, it is found that the proposed CS algorithm of Meyer wavelet gives better performance. The performance is evaluated in terms of SNR (Signal to Noise), PSNR (Peak Signal to Noise Ratio), MSE (Mean Square Error and mean compared to ABC and PSO based image denoising techniques. Also the testing is performed on the proposed techniques for the various satellite images. Moreover, the quantitative(EKI or EPI, mean, MSE, SNR, PSNR) as well as visual results of the de-noised images show the improved efficiency over the other conventional and state-of-art based image de-noising techniques.

Alam et.al.[6]proposed a technique by using PCA(Principal Component Analysis) along with the wavelet transform. In the proposed technique, decomposition of the image takes place. At first, the noisy image is decomposed followed by the PCA. The image is decomposed into various types of blocks. After this process, the Eigen values are calculated. Also in the decomposition process, from the each block, a common vector is eliminated. The noise is referred as a Gaussian random variable. In the process of de-noising, the de-noised image processed one more time by using the algorithm discussed above. For this purpose it uses the wavelet transform. This post processing results in further improvement of the solution when denoising process takes place. Also, the results of the experiments shows better performance in terms of PSNR when compared to another image de-noising methods in the wavelet transform.

From the literature survey it was found that K-means clustering has a very good performance for feature extraction and noise removal but there were few limitations. The major drawback in k-means clustering is that it is sensitive to initialization. SOMs provide a more robust learning. Hence there is another alternative if there is a need for a stable alternative to k-means. It has been observed from the results of implementation that for some cases there is difference in clustering results among these two methods. Further, it was found that using more efficient methods we can overcome the drawbacks. Improvement in image denoising is expected by using other clustering techniques.

III CONCLUSION

The current research works indicates the ability of the proposed denoising methods. However, further investigations may improve the recovered images under different multiplicative noise condition. During the research work, a few directions for further research have been identified. These are stated below:

- Exploring various thresholding techniques in sparse domain.
- Developing restoration technique in real-time systems.

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