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Image De-noising by using Nonparametric Model to improve the Quality of Digital Image

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Abstract:

Digital image processing and analysis techniques are used today in a variety of problems. Many application oriented image analyzers are available and are working satisfactorily in real environment. Important application of image processing techniques is improvement of quality or appearance of a given image. In this work different kind of image de-noising methods elaborated and also tried to improve the quality of image by removing the noise from the image. Image de-noising is a vital image processing task i.e. as a process itself as well as a component in other processes. Several de-noising procedures are proposed to preserve the image quality in textured images by removing the noise encountered. In literature survey, there are many ways to de-noise an image or a set of data and methods exists. The important property of a good image de-noising method is that it should completely remove noise as far as possible as well as preserve edges. Traditionally, there are two types of methods i.e. parametric method and non-parametric method. On parametric methods relies on particular parameter of the image and that is why they require a regular sampling of the image over a grid. On the other hand, Non-parametric methods rely on the data itself to dictate the structure of the model, and handle edges in a much better way than parametric method. One popular model for nonparametric image de-noising is the Kernel Regression method. By analyzing the results it can be said that proposed algorithm is giving an efficient output then the existing and it saves little bit less amount of time for executing the algorithm.

Keywords: Image processing, image de-noising, kernel regression, parametric and non parametric methods

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1.Introduction

Image processing is basically the use of computer algorithms to perform image processing on digital images. Digital image processing is a part of digital signal processing. Digital image processing has many significant advantages over analog image processing. Image processing allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and signal distortion during processing of images. Ease of use and cost effectiveness has contributed to the growing popularity of digital imaging systems. However, inferior spatial resolution with respect to traditional film cameras is still a drawback. The apparent aliasing effects often seen in digital images are due to the limited number of CCD pixels used in commercial digital cameras. Using denser CCD arrays (with smaller pixels) not only increases the production cost but can also result in noisier images. As a cost efficient alternate, image processing methods have been exploited through the years to improve the quality of digital images. Image de-noising is a vital image processing task i.e. as a process itself as well as a component in other processes. There are many ways to de-noise an image or a set of data and methods exists. The important property of a good image de-noising method is that it should completely remove noise as far as possible as well as preserve edges. Traditionally, there are two types of methods i.e. parametric method and non-parametric method.

2. Existing Methods

There are two types of methods i.e. parametric method and non-parametric method.

(I) Parametric Methods

Mostly in earlier days parametric methods are used for the purpose of de-noising the image. Classical parametric image processing method rely on a specific model of the signal of interest and seek to compute the parameters of this model in the presence of noise. In parametric methods some particular parameters of the image are calculated and a generative model based upon the estimated parameters is then produced as the best estimate of the underlying signal. But the main problem with the parametric method is that it generally intended for a more global fit. It doesn't the small characteristic of the data but deals with the overall parameters of the image. Second, it requires the equally spaced sampling structure. So these are the different disadvantages of the parametric methods though it is very useful methods for some particular images which are regularly sampled [1], [3].

(II) Non Parametric Methods

Nonparametric methods rely on the data itself to dictate the structure of the model, in which case this implicit model is referred to as regression function .Non parametric methods doesn't rely on regular sampling over the grid. It depends on the data of the image itself [1],[3] and this approach is useful for both images de-noising as well as image interpolation. Various on-parametric methods for image de-noising are also described here.

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(A) Classic Kernel Regression Method

Kernel regression provides a rich mechanism for computing point-wise estimates of the function with minimal assumptions about global signal or noise models. Kernel Regression method estimates the local linear combinations of the data. Naturally, since this approaches based on local approximations, a logical step to take is to estimate the parameters from the data while giving the nearby samples higher weight than samples farther away.

The choice of the particular form of the function is open, and may be selected as a Gaussian, exponential, or other forms which comply with the above constraints. It is known that for the case of classic regression the choice of the kernel has only a small effect on the accuracy of estimation [6].

(B) Data-Adapted Kernel Regression

Local polynomial kernel regression estimates, independent of the order are always local *linear* combinations of the data. As such, though elegant, relatively easy to analyze, and with attractive asymptotic properties, they suffer from an inherent limitation due to this local linear action on the data. Data-adapted kernel regression methods rely on not only the sample location and density, but also on the radiometric properties of these samples. Therefore, the effective size and shape of the regression kernel are adapted locally to image features such as edges.

(a) Steering kernel Regression

It is a two-step approach where first an initial estimate of the image gradients is made using some kind of gradient estimator (say the second order classic kernel regression method). Next, this estimate issued to measure the dominant orientation of the local gradients in the image. In a second filtering stage, this orientation information is then used to adaptively "steer" the local kernel, resulting in elongated, elliptical contours spread along the directions of the local edge structure. With these locally adapted kernels, the de-noising is affected most strongly along the edges, rather than across them, resulting in strong preservation of details in the final output [1].

(b) Iterative Steering Kernel Regression

Steering kernel regression is most effective when an iterative regression/de-noising procedure is used to exploit the output (less noisy) image of each iteration to estimate the radiometric terms of the kernel in the next iteration. A block diagram representation of this method is shown in fig, where is the iteration number. In this diagram, the data samples are used to create the initial (dense) estimate of the interpolated output image. In the next iteration, the reconstructed (less noisy) image is used to calculate a more reliable estimate of the gradient and this process continues for a few more iteration [1].

ISSN: 2348 9510
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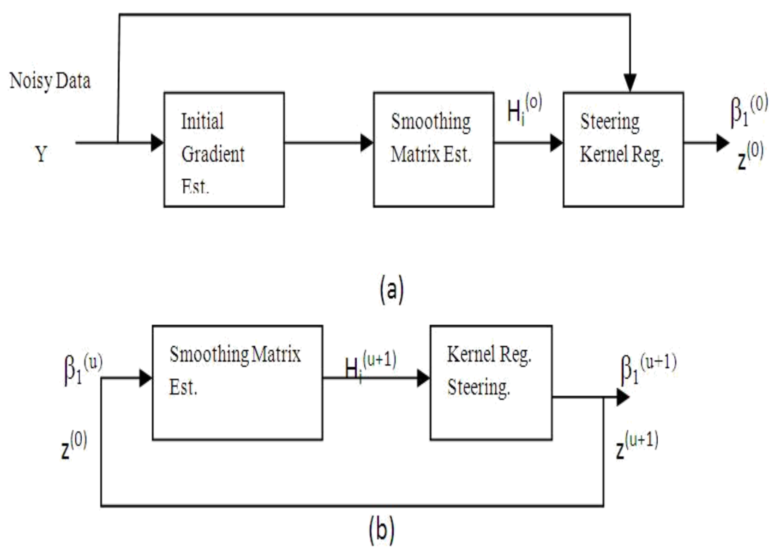

Fig.1 Block diagram representation of the iterative steering kernel regression **[1].**

(a) Initialization (b) Iteration

In the Iterative steering kernel regression method steering kernel regression method executes iteratively for the better de-noising of the image. But the main problem in this method is that the number of iterations for the images is not fixed. Numbers of iterations are different for different kind of noises and images so if we apply the number of iterations more than the best iteration for that image then image gets blurred and if we apply the number of iterations below the best iteration for that image will remain noisy. So it becomes necessary to optimize this number of iterations for the particular image to get the properly de-noised image [1].

3. Proposed Methodology

The objective of this paper is to propose an efficient optimization technique to optimize the number of iterations in the iterative kernel regression method where the numbers of iterations are not fixed to de-noise the image.

Following strategy which will optimize the number of iteration for particular image.

Step1. Read Image

Step2. Take sample from image

ISSN: 2348 9510
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Step3. Select maximum number of iteration

Step4. Apply iteration one by one on sample

Step5. Check condition if iteration = best iteration, select iteration as a best iteration otherwise apply iteration one by one on again.

Step6. Apply iterative steering kernel regression method with I iterations

Step7. Output image

4. Result Analysis

For image analysis, de-noising is very crucial. If Image de-noising process is not proper then all the analysis goes wrong. It fills the gap between high and low level of image processing. Image de-noising is needed for the analysis of the images in every field. In medical field images must be clear to detect the dieses and bones from the images of the patient’s body. So, Image de-noising methods are used in almost every field. Mostly it is used in medical and science field for the better analysis of images. Image de-noising also can be used in industries and in satellite images for better viewing of image. So the higher need of images to be clear and sharpen gives inspiration for image de-noising to improve the quality of image.

Fig.2 Lena Original image

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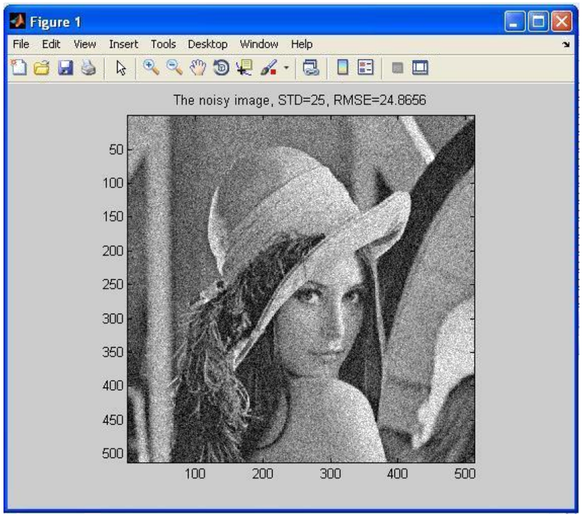

Fig.3 Lena Noisy Image

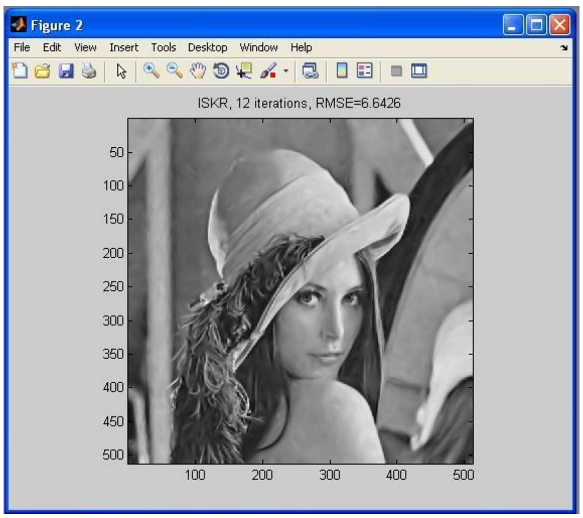

Fig.4 Lena Result Image

ISSN: 2348 9510
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Volume 1, Issue 5, August 2014

Fig.5 Priyata Original Image

ISSN: 2348 9510
International Journal Of Core Engineering & Management (IJCEM)
Volume 1, Issue 5, August 2014

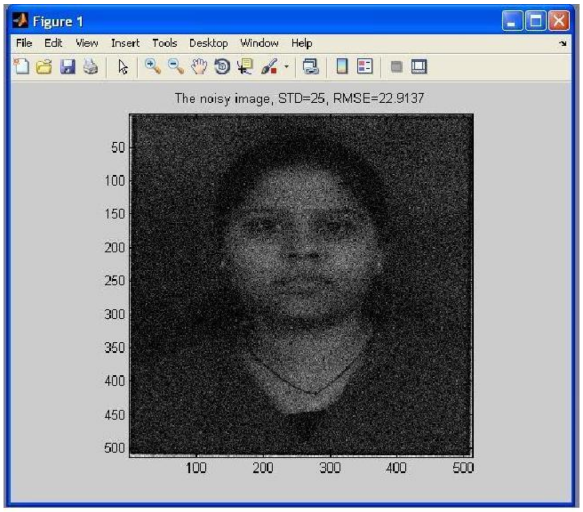

Fig.6 Priyata Noisy Image

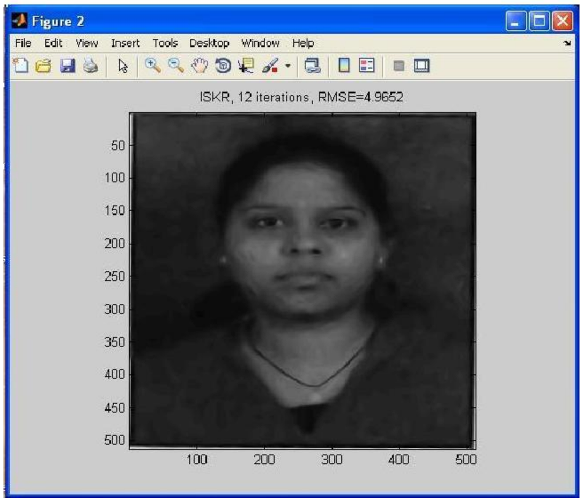

Fig.7 Priyata Result Image

ISSN: 2348 9510
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Volume 1, Issue 5, August 2014

No of Iterations	Lena.png RMSE	Priyata.png RMSE
1	19.4974	16.6114
2	15.4988	12.4851
3	12.8815	10.0529
4	11.0735	8.4015
5	9.7225	7.1693
6	8.6819	6.2424
7	7.8919	5.5740
8	7.3244	5.2242
9	6.9517	5.0389
10	6.7385	4.9211
11	6.6468	4.9250
12	6.6426	4.9652

Table 1: RMSE values for each iteration

Above table contains the RMSE values of different 2 images on which proposed algorithm is applied and it can be seen from the table that number of iterations required for each image is different and proper number of iterations are came out by applying the proposed algorithm on noise for example for Lena it is 12.8 where for Priyata image it is 10 at iteration 3. In iteration 12, Lena is 6.6 whereas Priyata is 4.9.

5. Conclusion

Based on the experiment results it can be said that proposed algorithm reduces time required to execute the algorithm and also gives the proper de-noised image. By analyzing above both the images and result images it is observable that by applying the proposed algorithm proper de-noised image can be obtained in lesser time than the other one. Algorithm is also working for color images and it is executing the iterations depends on the image and giving the right de-noised image.

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ISSN: 2348 9510
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