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An Enhanced Non Local Based Algorithm for Image Denoising

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Abstract- The visual appeal of image makes it inevitable to a number of research and technological advancement in the field of image processing. Images are being transmitted digitally at very rapid pace and in large amounts nowadays. The images are infected by noise while transferring. Non-local means is popularly used in the spatial domain for denoising application of images. Bilateral filtering features have been used in this proposed method to construct an improved non-local means based algorithm. The implementation of working improved non local means algorithm has been done using MATLAB software tool, along with the simple non local means algorithm with bilateral filter.

1. Introduction

The growing number of digital imaging devices has led to increase in image processing applications, in last few decades. Everyone nowadays prefers image in comparison to written text because it adds up to the look and feel of the message sent [1]. There are several requirements in which, the raw image needs to be converted into some or the other form leading to change in its characteristics [2]. All such modifications on the input image are parts of image processing. Mathematical models are used to represent image as 2-D signal and thus several signal processing techniques across both the dimensions to form image processing methodologies [3]. There are several image processing applications that need analysis to be located in the temporal domain. These can be achieved using the Window based Fourier Transform. Short Time Fourier Transform reflects the central concept of windowing [4]. It is quite very common that some "aberrations" are introduced when the input image is collected and thus a noisy image for future processing is generated. Images which have been affected by some form of noise are called distorted images and require for image denoising methods at the output or end point of the transmission network [5]. As an example figure 1.1 shows the two images one is a clear image shown in figure 1.1(a) whereas the second image shown in figure 1.1(b) is hazy or affected by some kind of noise.

(a)

(b)

Figure 1: Difference between Clear and Noisy image

Several manipulations can be occurred in the original images due to presence of unwanted signals like the spikes. Such noise elements can affect the viewing experience of images or videos, such as some black spots or spikes, sometimes appears during faulty transmission [6]. There exist several image processing algorithms which can be used to remove the noise elements in the picture or video.

2. Related Work

For the identification and elimination of high noise levels of salt and pepper P.Zhng et.al[7] proposed new adaptive weighted average filter. The two windows used here are made equal in their maximum and minimum values, of window size and adaptive size is obtained. A pixel is then claimed to be noise free only if it is equal to the average or minimal of the two windows. Lastly, the pixels which are not noise pixels are replaced by weighted mean of current window, whereas the noisey pixels are remain unchanged. Comparisons with other techniques have been performed which show the low detection and high restoration efficiency of the proposed filter, in particular for high-grade noise.

The two-stage method for images of Poisson was introduced by N.Huang et.al[8]. This method enhances the current non-local two-stage Poisson image (Poisson NLM) means that compares soundy patches and patches with preestimated image based on probabilistic similarities. The preestimated image is achieved in Poisson-NLM using a simple Gaussian convolution that is fast, but not efficient for the image with a very few photons. Numerical experiments show, particularly with Poisson photons with an extreme low number, that the method efficiently improves the result both visually and quantitatively.

As per Siyu Luet.al,[9] non-local means algorithm has proved itself to permit a good image restore output of Magnetic Resonance images. However, all image pixels are used by this system, some of which are useless to eliminate noise. An enhanced, non-local pixel-selection means an algorithm that prevents unnecessary pixels from being used. The pixel selection theory is based on the correlation between median value neighborhoods and mean absolute noise error. The denoising efficiency is measured using quantitative methods. The pixel selection algorithm has been tested on artificial and real images and the outcome is usually satisfactory with the denotation of MR images.

According to M.P Nguyen et.al[10], it is important for filtering to assign center pixel weights in a non-local medium. Use local James-Stein style CPW the output of center pixels was superior to the NLM by other existing methods. However, the initial LJS CPW method did not implicitly assume that it could produce excessively large self-weight and visual devices for auto-weight purposes. It is suggested that minimal self-weight LJS be merged into LJS so that this new estimator is partially dominant. A patient MR image with 3 additive noise levels was used to evaluate the proposed procedure. The suggested BLJS generated lower variances for almost all bias rates for the defined local area than the original LJS. BLJS has also been able to achieve PSNR equivalent or better than LJS. Visual assessment of the image quality has shown that less localized visual artefacts were generated by BLJS than LJS.

3. Methodology

The non local mean filter uses resemblance of the pixels of images that benefit from redundancy in order to remove the noise. There is a similar window here, every window consists. The limitations of many conventional filters are improved. Not only does the pixel degree of intensity correlate with the spatial structure of the entire neighbourhood, the NLM filter.

The pixel intensity of the restored image is the weighted average of all pixel intensities. This non-medium filter offers thorough protection of noise suppression. Figure 3.1, shows the Non Local Mean similarity approach. It can be seen that there are two types of windows search and similarity windows respectively. Search window is of larger pixel size whereas similarity window is of smaller size. In search window there is a center pixel. Here the similarity window move through the search. Window and compare the pixel at each position with that of the search window. Similarity between two pixels can be quantitatively approximated by finding the Euclidean

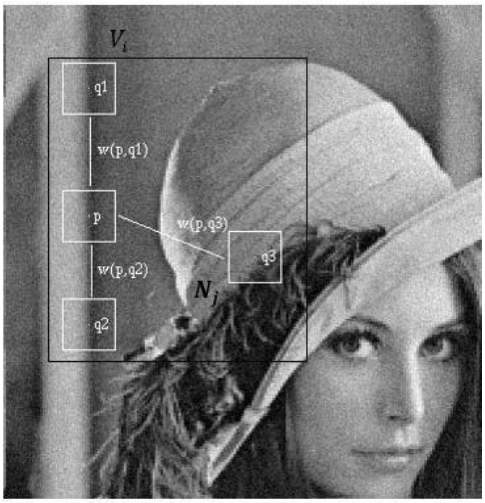

Figure 2: Non Local filter window

distance between them. In this way the similar pixels are awarded higher weights and dissimilar pixels gets less weights. Then the total averaging of all pixels is performed and thus the restored image is obtained.

The proposed "improved non-local means filter" uses bilateral filtering to optimize selection of patch size. The algorithm is as given below:

1. Calculate Image Size
   [m,n] = size(Input_image)
2. Select Kernel Size and values of σ1 and σ2.
3. Compute spatial domain Weights using the formula:

$$d(i,j,k,l) = \exp\left(-\frac{(i-k)^2+(j-l)^2}{2\sigma_d^2}\right) \quad 3.1$$

4. Normalize the pixels :
   Input_Normalized= Input_image/255;
5. Compute Intensity Domain Weights

$$r(i,j,k,l) = \exp\left(-\frac{\|f(i,j)-f(k,l)\|^2}{2\sigma_r^2}\right) \quad 3.2$$

6. Bilateral Filter weights are obtained by multiplying intensity domain and pixel domain weights:

$$w(i,j,k,l) = \exp\left(-\frac{(i-k)^2+(j-l)^2}{2\sigma_d^2} - \frac{\|f(i,j)-f(k,l)\|^2}{2\sigma_r^2}\right) \quad 3.3$$

7. The output pixel is computed as summation of weighted pixel values:

$$g(i,j) = \frac{\sum_{k,l} f(k,l)w(i,j,k,l)}{\sum_{k,l} w(i,j,k,l)} \quad 3.4$$

Result and Discussion

The algorithm has been implemented using MATLAB software tool. Extensive experiments using a number of test images have been performed by implementing both the simple non local means filter and the proposed

improved non local means filtering algorithm [11]. We have used standard images for our test purpose. Figure 3 shows the test images. These standard images are initially noise free.

Figure 3: Lena Barbara Image

Different experiments in many gray-level images with dimensions 256x256 and 512x512 are carried out in this phase with various parameters. For comparison reason, the pictures are used, including Lena, Barbara (512x 512) and boat, and Pepper (256x 256). We assume that Gaussian additive white noise is the noise pattern [12]. The selected image contains a noise. Although the use of the improved NLM algorithm greatly improves the performance of the picture and provides optimal results. Therefore, the image can be compared to the image without a filter application to add more performance [13]. It is seen in the figures below.

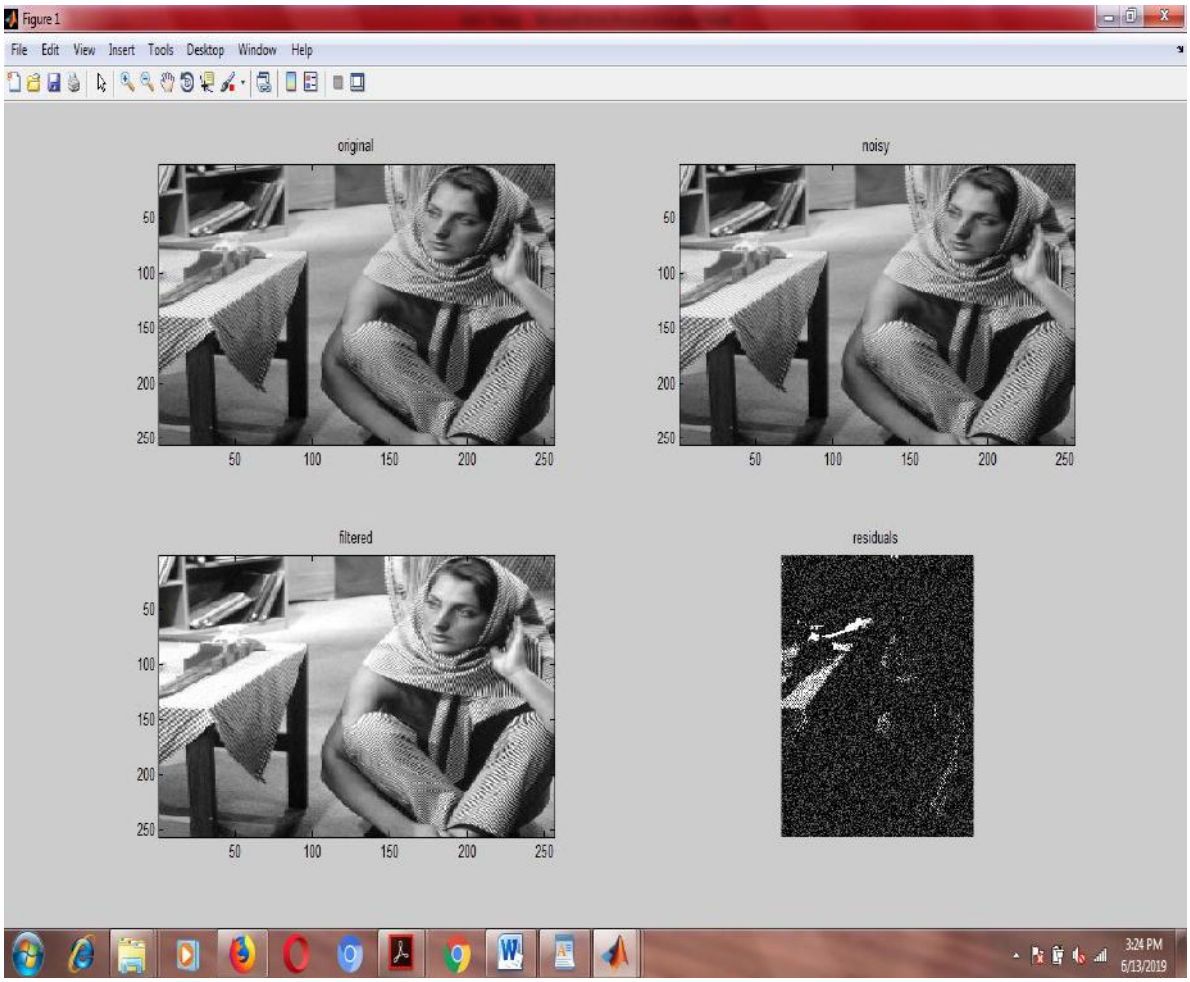

Figure 4: Simulation results for Barbara image

Conclusion

In this research work the image denoising problem has been taken into consideration. Images are being transmitted digitally at very rapid pace and in large amounts nowadays. The images are infected by noise while transferring. Non-local means is popularly used in the spatial domain for denoising application of images. Bilateral filtering features have been used in this proposed method to construct an improved non-local means based algorithm. The implementation of working improved non local means algorithm has been done using MATLAB software tool, along with the simple non local means algorithm. The evaluation of the proposed algorithm and get better clarity after filtering and less information loss in the image as compared to local mean algorithms.

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