IMAGE DENOISING ALGORITHM

TANMAY SINHA ROY

Dept. of ICE, Assistant Professor, Haldia Institute of Technology, Haldia- 721657, WB, India

ABSTRACT: Image Denoising plays vital role in digital image processing. The purpose of image denoising is to remove noise from any digital image. Any digital image is comprised of pixels of different size of matrices. Various Image Restoration algorithms have been developed. In this paper, we have compared pixels of two different images one, the original image and the other, the degraded image. Once we get the difference between the two pixels which can be called as the added noise then we have subtracted that noise from the degraded image. In this way the original image can be restored from the degraded image.

KEYWORDS- Denoising , Degraded, Restoration

1. INTRODUCTION

Image processing is one of the most important area of multimedia applications and it is known, these applications can be found almost everywhere in the modern world. Because of that, the number of people working with images is rapidly increasing which means, that demand for image processing tools also grows. Images are being compressed, decompressed, sent over the internet, modified or distorted in various ways and all these things affect their quality. It is the key element for multimedia to be able to assess the quality changes, predict them and eventually correct them. An image defined in the "real world" is considered to be a function of two real variables, for example a(x, y) with a as the amplitude (e.g. brightness) of an image at real coordinate position (x, y).An image may be considered to contain sub images also called as regions-of-interest or regions. Image is a collection of objects. The amplitude of a given image will always be either real number or integer number. A quantization process converts a continuous range (say between 0 and 100%) into a discrete number of levels. A sampling process that converts an analog image a(x, y) in a 2D continuous space to a digital image a [m, n] in a 2D discrete space is called digitization. The 2D continuous image a(x, y) is divided into N rows and M columns. The intersection of a row and a column is called a pixel.
The important Application of image Processing is the Spatial Domain Filtering. It offers two main options – Linear and Non-linear filtering. Linear filtering section contains number of linear filters based on *fspecial( )* and *imfilter( )* functions in MATLAB. Under Linear filtering of images Average Filter, Gaussian, Laplacian, Sobel comes. Results of this filtering are well obtained in Matlab.
Non-linear filters are especially useful when applied on the images distorted by "salt & pepper", noise field, "Gaussian" noise field, "lognormal", "Rayleigh" and "Exponential" noise fields. It includes Median filters and Adaptive Median filters. The size of the neighborhood for the median filter is 3 x 3 pixels, 5 x 5 pixels, 6 x 6 pixels, 7 x 7 pixels,10 x 10 pixels. As can be seen the median filter suppresses the noise but slightly blurs the image (the larger the neighborhood is, the more blurred is the output. The suppression of the noise is not as good as by median filtering but the output images are not blurred at all. Moreover the results are almost the same for the size of neighborhood 3 x 3 and 10 x 10 pixels. But with the help of Linear Average filters the images become blurred as we increase the size of the mask. So in this way, we do not get the Restored image properly from the degraded image.
In this paper, we have developed an algorithm that will not only restore the original image, it will also keep the image quality of the original image. we have degraded the original image with the help of some added noise like "salt & Pepper noise", "Gaussian noise", then we have compared the image matrices of two images on pixel by pixel basis. Once we get the error between the two pixels we subtracted that error from the degraded image pixel matrix. For the computation of the error matrix, we have to keep in mind that which pixel is larger and that larger pixel has to be subtracted from the smaller pixel.

2. LITERACY SURVEY

Image Denoising is the process of removing noise from a digital image. Image denoising is an important image processing task, both as a process itself, and as a component in other processes. Very many ways to denoise an image or a set of data exists. The main properties of a good image denoising model is that it will remove noise while preserving edges. Traditionally, linear models have been used. One common approach is to use a Gaussian filter, or equivalently solving the heat-equation with the noisy image as input-data, i.e. a linear, 2nd order PDE-model. For some purposes this kind of denoising is adequate. One big advantage of linear noise removal models is the speed. But a backdraw of the linear models is that they are not able to preserve edges in a good manner: edges, which are recognized as discontinuities in the image, are smeared out. Nonlinear models on the other hand can handle edges in a much better way than linear models can. One popular model for nonlinear image denoising is the Total Variation (TV)-filter, introduced by Rudin, Osher and Fatemi. This filter is very good at preserving edges, but smootly varying regions in the input image are transformed into piecewise constant regions in the output image. Using the TV-filter as a denoiser leadss to solving a 2nd order nonlinear PDE. Since smooth regions are transformed into piecewise constant regions when using the TV-filter, it is desirable to create a model for which smoothly varying regions are transformed into smoothly varying regions, and yet the edges are preserved. This can be done for instance by solving a 4th order PDEd instead of the 2nd order PDE from the TV-filter.

Currently Image Denoising approach, based on properties of an image, is divided into two categories:

2.1 Linear Filtering: Average Filter, Gaussian, Laplacian, Sobel filter are some of the examples of linear filtering. The linear operation consist of multiplying each pixel in the neighbourhood by a corresponding coefficient and summing the results to obtain the response at each point (x. y).If the neighborhood is of the size m x n, mn coefficients are required. The coefficients are arranged as a matrix called a filter mask. The process consists of moving the center of the filter mask(w) from point to point in an image, f(x, y).At each point (x, y),the response of the filter at that point is the sum of products of the filter coefficient and the corresponding neighborhood pixels in the area spanned by the filter mask. Filter mask are always having odd sizes of m x n.

Average Filters*:* These filters filter out the digital image using the filtering modes such as convolution and correlation. They not only do not able to suppress the noise also, as if we keep on increasing the mask size the image will also get blurred and unsharp. In the below given images we have shown this.

FIG-1 ORIGINAL IMAGE

Fig.1 is a uint8 original image which contains 0-255 total intensity levels. This image is stored in f matrix. The size of the image is 384 x 512 pixels. This image is degraded by salt & pepper noise which is shown in Fig-2 and this image is stored in g matrix. Finally the image which we get after restoration is shown in Fig-3.

$g(x, y)=f(x, y)+\eta(x, y)$

Where **$g(x, y)$** is the restored image matrix, **$f(x, y)$** is the original image matrix and **$\eta(x, y)$** is the added noise matrix in the original image.

FLOW-CHART OF THE ALGORITHM USED

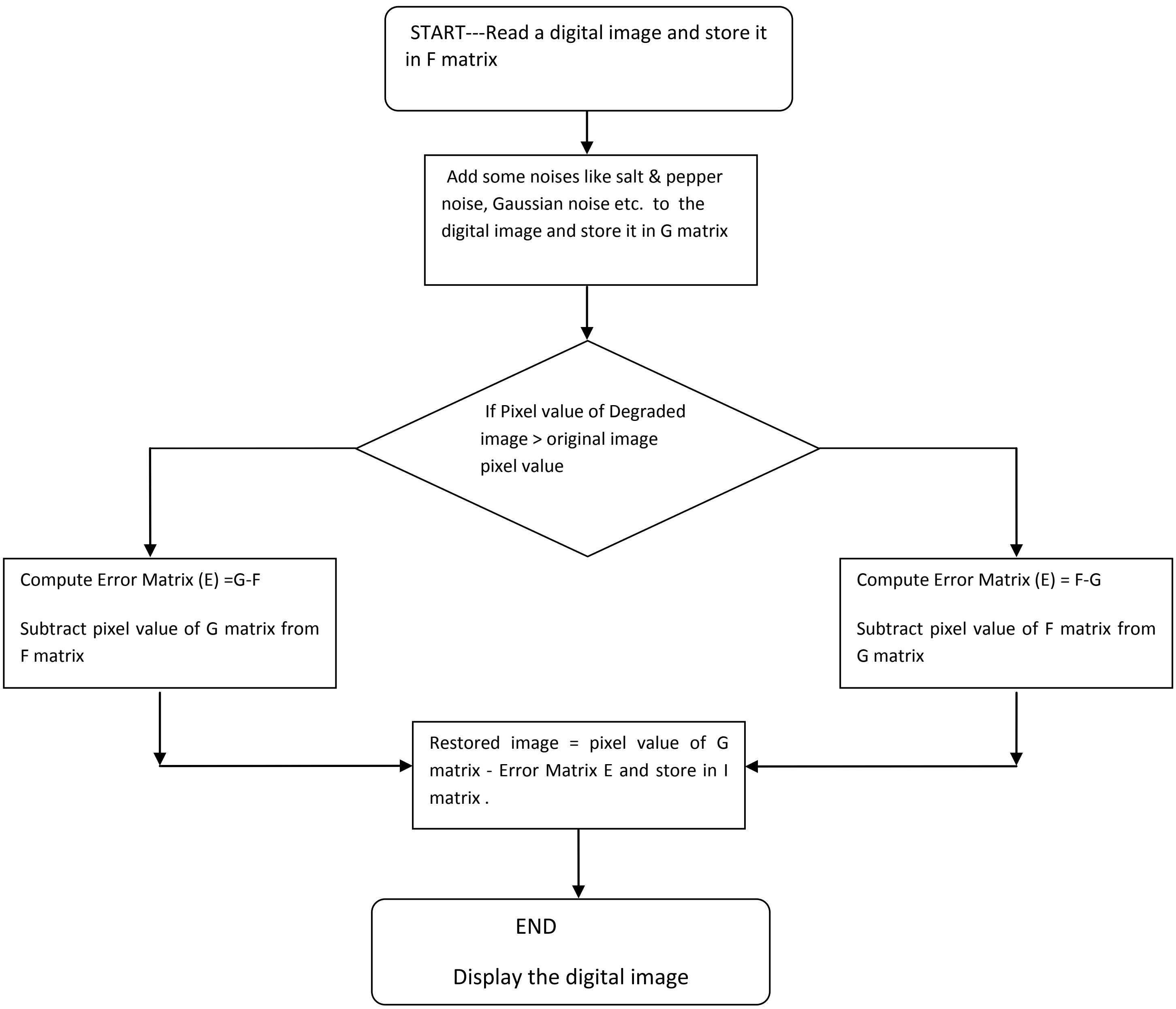


FIG-2 Denoised image by average filtering of Mask Size 3

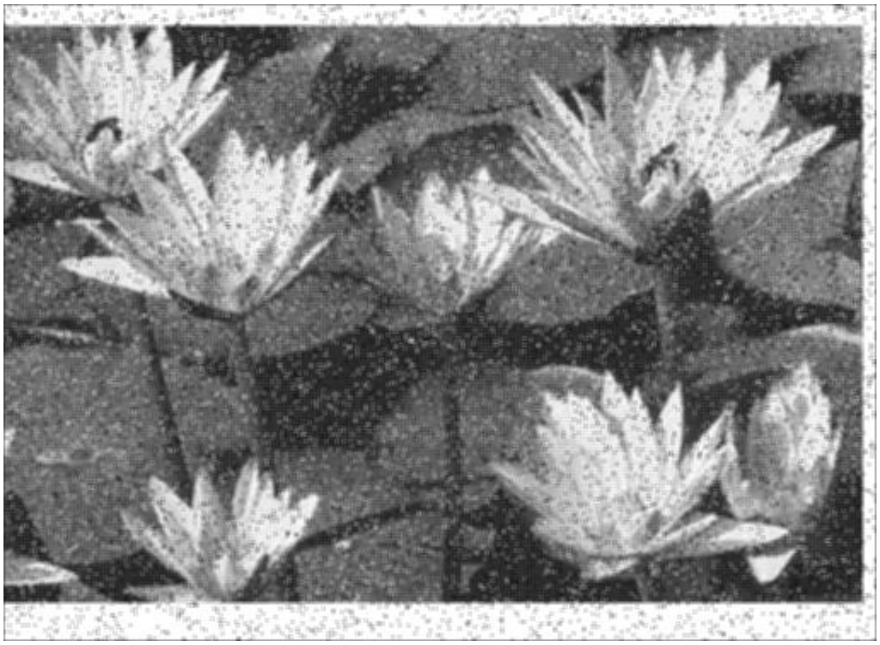
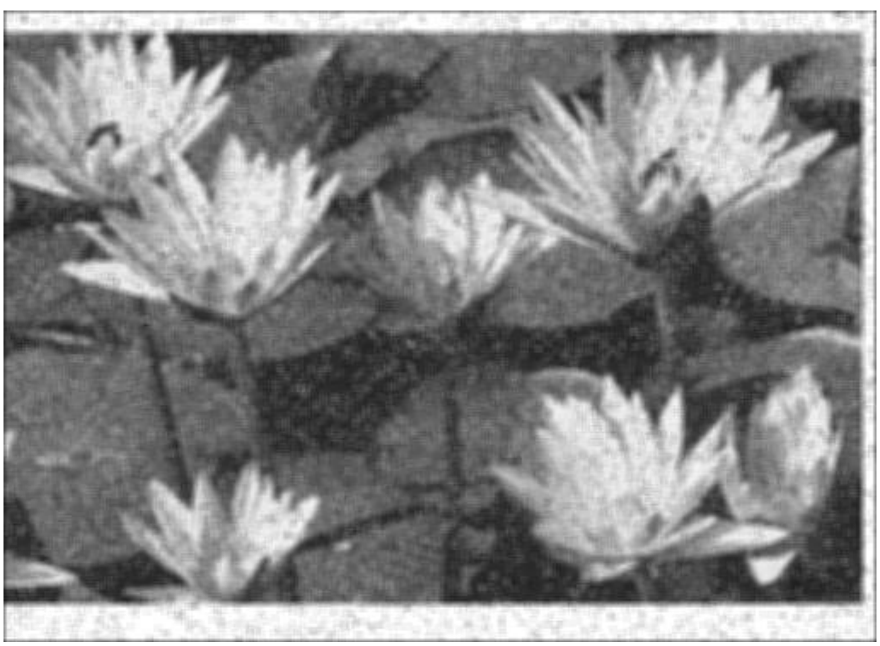


FIG-3 Denoised image by average filtering of Mask Size 5



Laplacian Filter*:* This Linear filter cannot be able to suppress the noise present in the image but it will keep the sharpness of the image. The filtering operation based on the laplacian mask shown below.

w = **[0 1 0; 1 -4 1 ; 0 1 01;**

FIG-4 Denoised image by Laplacian Filtering

3. NON-LINEAR FILTERING

Median filtering and adaptive Median Filtering are some of the examples of Non-Linear Filtering. Non-Linear filtering is also based on neighborhood operation. However, whereas Linear filtering is based on computing the sum of products (which is a linear operation), Non-Linear filtering is based as the name implies on Non-Linear operation involving the pixels of the neighborhood. For example, letting the response at each center point be equal to the maximum pixel value in its neighborhood is a Non-Linear filtering operation. In case Of Non-Linear filtering any uint8 digital image when gets filtered out by different sizes of mask the digital image gets blurred as the size of the mask gets increased but it will keep the sharpness of the image and the noise will also get suppressed out. In the below given images, we have shown the output that we have obtained from median filtering.

FIG-5 Denoised image by Median filtering Of Mask size 3

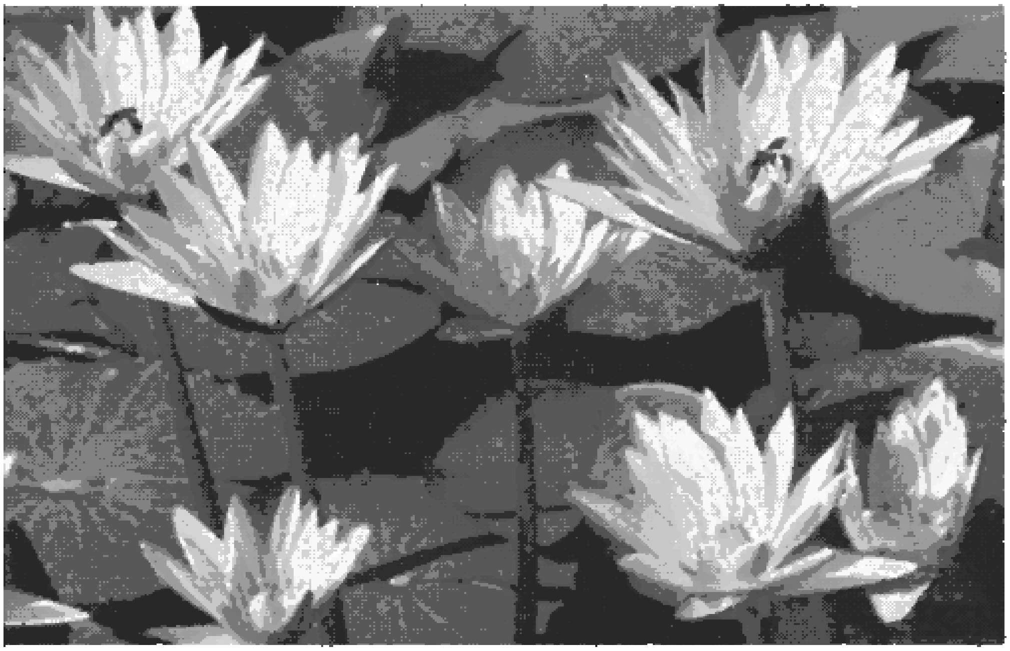
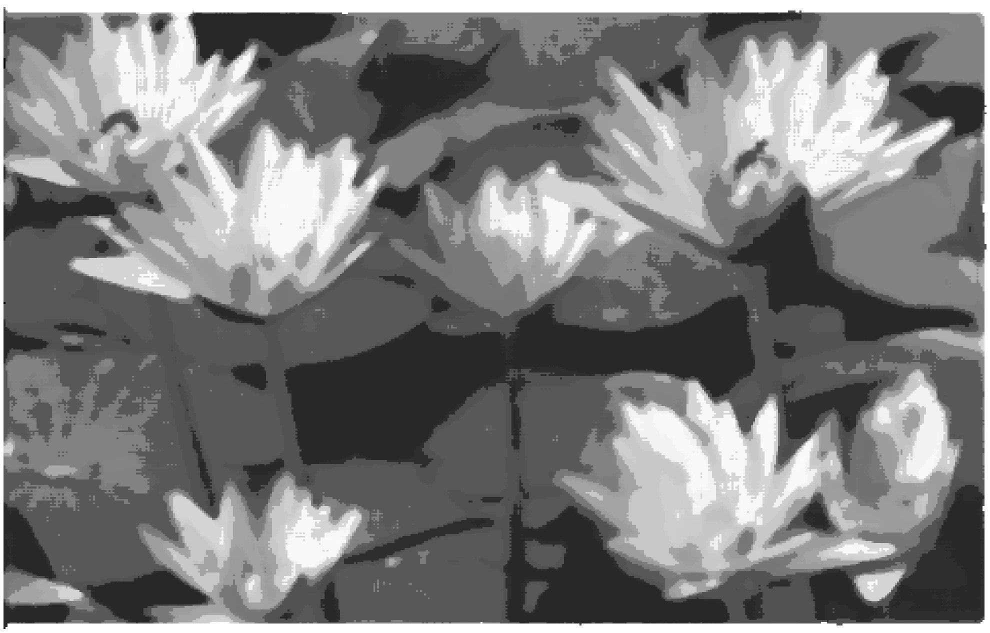


FIG-6 Denoised image by Median filtering Of Mask size 7



In this paper, we have considered **η(x, y)** as salt & pepper noise and Gaussian noise. We have added these noises with the uint8 image that we have considered earlier. After that we have used this algorithm for restoration of the original uint8 image from the noise added image. Two different noise-added images we have considered and then we have applied this algorithm on these two noise added images and got the denoised image as shown below.

4. RESULTS AND INTERPRETATIONS

FIG-7 SALT & PEPPER ADDED NOISE

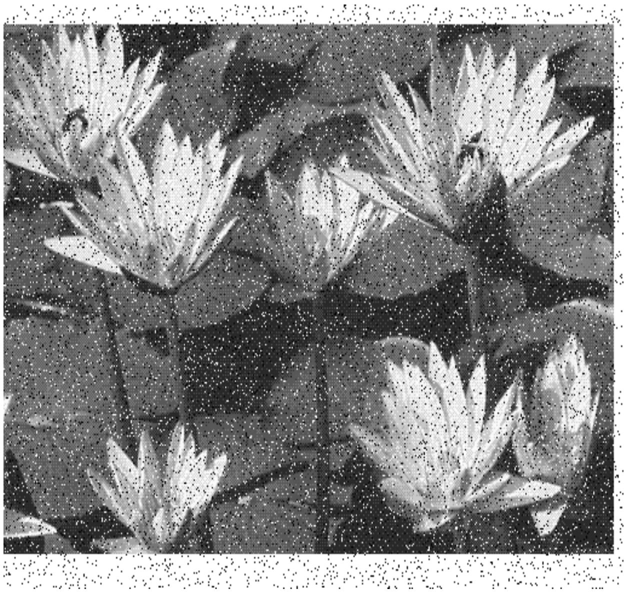


FIG-9 GAUSSIAN NOISE ADDED IMAGE

FIG-8 DENOISED IMAGE BY USING THIS ALGORITHM

FIG-10 DENOISED IMAGE BY USING THIS ALGORITHM

5. CONCLUSION

In Recent years, we have seen after going through different research paper that no algorithm is suitable for all types of noises. One Algorithm that is suitable for one set of noise may not be suitable for another set of noise. However, in this paper, we have compared different algorithms and obtained the different restored images. We found that this algorithm is applicable for all kind of noises. This algorithm will not only suppress the noise to a larger extent, it also preserves the sharpness of the image.

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