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Performance Assessment of Reclamation Methods for various Distorted Images

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Abstract

Objectives: Performance Assessment of Reclamation Methods aims to analyse the various performance parameters of reclamation techniques for a distorted image. Due to rapid modernization and advancement of technology in last decades, the importance and need of reclamation of image is rapidly increasing and hence need for better way to reclaim an image in best way possible is to be determined. **Methods/Statistical Analysis:** An approach has been made in this paper to examine that which reclamation method is best for which kind of degraded image (type of noise introduced to image). Basic approach is to find out how filters can be used for restoring or reclaiming an image in such a way that the reclaimed image's maximum quality is achieved, because image processing is one of the major feature in Artificial Intelligence, which has emerged as huge and powerful field in technology. **Findings:** By comparing original image's quality and reclaimed image's quality we can determine which reclamation method suits for which kind of noise and hence the reclamation of image will get easier. **Application/Improvements:** This paper helps selecting the most preferable and efficient reclamation method in restoring degraded images.

Keywords: Image Degradation and Eruption, Image Filtering, Image Processing, Mean Structural Similarity Index, Performance Assessment of Reclamation Methods

1. Introduction

With rapid advancement in the field of digital imaging and communication technology[1] filtering, compression, decompression, reclamation, etc. of image has been becoming an essential subject in colossal applications.

Image reclamation[2] is described as the mechanism of retrieving the ideal image from the distorted image by using the important knowledge of reclaiming phenomenon. Reclamation of image has wide scope in many fields such as Science, Medical, Remote sensing, Forensic study, Material Science, Military, Film-making industry, etc. Image recovery works in a way where a corrupted or distorted image is considered and estimation is made to figure out the original image. It helps in erasing and amending the errors that effect negatively on the original image.

Various types of noises like salt and paper, speckle noise, Gaussian noise, motion blur, etc. are added to a considered test image and then different reclamation methods are used to reclaim the degraded image. After that the quality is measured of reclaimed image and compared to that of the original image because after degradation restoring original image at 100% is impossible. So basic approach of this paper is to observe and examine that which reclamation method is more suitable for which type of noise.

As we know[3] images are ubiquitous and crucial in day to day life, the PARM is very helpful in determining the better method of restoring the degraded or defected image. In every field images are used and securing and restoring them has become an important factor, so analysing the work of all filters when applied to noise added image is done. Restoration[4] or reclamation is necessary, because digital images are used in security purpose like in military or in forensic labs, original image can be restored up to many degrees if we know which noise is introduced in image and which filter must be applied to it.

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This paper is organised in the manner as Section I presents the Introduction to the topic of this paper, Section II presents the Literature Review in three parts- Various types of noises, various types of filters, and MSSIM, Section III presents Image Eruption and Reclamation in detail, Section IV presents Result and Discussions, Section V presents Conclusion and Future Scope, and at last References.

2. Literature Review

In this paper we are using various noises to degrade an image, then applying various filters to reclaim it and then at last comparing the qualities of the reclaimed image and original image using MSSIM.

2.1 Noise

Noises occur in any digital image during image acquisition and some of them are explained:

- Speckle noise: This noise[2] is an impure noise that usually remain in and erupting the quality of the synthetic aperture radar pictures.
- Additive noise: It expresses stoical noise having probability density function (PDF) comparable to that of the Gaussian distribution. Principal sources of Gaussian noise in digital images arise during acquisition.
- Salt and Pepper noise: Impulsive noise is called salt-and pepper noise or spike noise. When an image has salt-and-pepper noise, it contains the darker pixels' in brighter regions and brighter pixels in darker regions. This type of noise occurs by A/D converter errors, bit errors in transmission, etc.
- Motion Blur: It arises due to proportionate mobility between the capturing gadget and the set. This can be in the form of a translation, a rotation, a sudden change of scale, or some combinations of these. Example: Imagine a scenario where a picture is being clicked by a camera, and suddenly while clicking the camera is disturbed, and so the obtained image is blurred.

2.2 Reclamation of Image

In reclamation of image, various filters are applied to the degraded image and then the recovered image is obtained. There are various types of filters: Wiener filter, Gaussian filter and Median filter. They are briefly described as below:

- Wiener Filter: Itdefines a speech-distortion index[5] to measure the degree to which the extent image is deformed and two noise-reduction factors to evaluate the bulk of noise being extenuated.
- Median Filter:It is a novel[6,7] nonlinear filter, called tristate median (TSM) filter, which works for reclaiming image details while effectively suppressing added noise, also a framework is used to figure out whether a picture element is corrupted or not, before applying filtering unconditionally.
- Gaussian Filter: The Gaussian filter[8,9] is a linear filter that polishes the degraded image irrespective of its elements. The extension of bilateral filter: multi-resolution bilateral filter, where bilateral filter is applied to approximation sub bands of an image degraded and after each step of wavelet reconstruction.

2.3 Mean Structural Similarity Index (MSSIM)

The basic thought veiling the structural similarity approach[10,11] is that the HVS is highly fitted to excerpt structural information from ocular scenes. SSIM Index is refined by seeing both structural and non-structural misrepresentations. This SSIM has three parts: luminance comparison l(**x, y**), contrast comparison C(**x, y**) and structure comparison s(**x, y**).

Let,

$$\mathbf{X = \{x_i | i = 1, 2, .. N\} and Y = \{y_i | i = 1, 2, .. N\}}$$

be the original and test image signal respectively.

$$\mathbf{SSIM = [l(x,y)][c(x,y)][\,e(x,y)] \ldots\ldots (1)}$$

$$\mathbf{Let, X = \{x_i | i = 1, 2, \ldots\ldots N\} and Y = \{y_i | i = 1, 2, \ldots\ldots N\}}$$

$$\mathbf{MSSIM(X, Y) = \frac{1}{M}\sum_{j=1}^{M} SSIM\left(x_j, y_j\right) \ldots (2)}$$

3. Image Eruption and Reclamation

Two parts are observed in this section. The image is first erupted and then reclaimed. The stages for image eruption and reclamation are shown in following flow diagram step-wise:

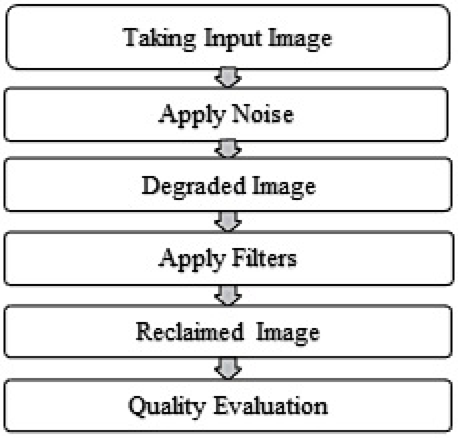

Figure 1. Design Methodology.

3.1 Degrading Image

A degraded image is an image in which different noises are introduced. There are various forms of noise used are:

- Additive noise
- Motion Blur
- Salt and paper noise
- Speckle noise

These noises are one by one added to a reference test image and each type of degradation is observed.The reference images considered in this paper on which the noise are added and filters are applied are as below:

(a)

(b)

Figure 2. Reference images for testing (a.) Harbour (b.) Horse.

3.2 Reclamation of Image

An image is reclaimed, where the degraded image is reclaimed. Though completely the image cannot be restored as data is lost when noise is added to it, so some filters are applied and each filter has its own capacity to restore an image with noise added up to a specific degree. The various filters used are:

- Wiener Filter
- Gaussian Filter
- Median Filter

Quality must be evaluated and compared between the original image and the reclaimed image. To evaluate it we perform Mean Structural Similarity Index (MSSIM) to the reclaimed image.[12]

Each reclaimed image for every degraded image is compared. Conclusion is made on the observation of most suitable filter for restoring image from each kind of noise added to it.

4. Result and Discussion

We consider two reference or test images, different noises are added to them and observed and then three filtering methods are applied to reclaim the original image. All this noise addition and filtering is done in MATLAB with noise addition codes and image filtering codes.

Firstly, after addition of various noise to one selected reference image the following are the result:

(a)

(b)

(c)

(d)

(e)

Figure 3. Standard 8-bit Harbour image corrupted by different distortions. (a)Ref. Image (b)Additive Noise added (c)Motion Blur added (d)Salt and Paper Noise added (e) Speckle Noise added.

Then, after application of filters on these degraded images the reclaimed images are shown as below:

4.1 Application of Wiener Filter

(a)

(c)

(d)

Figure 4. Wiener Filter applied to image degraded with: (b) Additive noise (c)Motion Blur (d)Salt and Paper (e)Speckle Noise.

4.2 Application of Gaussian Filter

(b)

(c)

(d)

(e)

Figure 5. Gaussian Filter applied to image degraded with: (b)Additive noise (c)Motion Blur (d)Salt and Paper (e) Speckle Noise.

4.3 Application of Median Filter

As the observation are made, Table 1 clearly depicts that for which kind of noise which reclamation method is more suitable.

(b)

(c)

(d)

(e)

Figure 6. Median Filter applied to image degraded with:(b) Additive noise (c)Motion Blur (d)Salt and Paper (e)Speckle Noise.

MSSIM value must be high, approximately equal to unity[1]. The higher is the MSSIM value, higher is the quality of the reclaimed image. To find out which kind of filter is suitable for which type of noise will be decided on the basis of highest quality value obtained of reclaimed image.

According to the observations made, the results are: Gaussian filter works good for Additive noise and Motion blur, Wiener filter works good for speckle noise and Median filter works good for Salt and Paper noise.

5. Conclusion

The intention of this paper is to understand the basic need of reclaiming or restoring an image using various reclamation methods. As we know in last some decades Artificial Intelligence (AI) has been the new and powerful innovation in technology. Image Processing is one of its prime trait and reclaiming degraded/distorted images, giving them a new level of clarity, increasing their quality etc. are its some prior objectives. In this paper, four different kinds of noises are added to two grayscale test images, then filtering is done and finally which filter suits most for which noise is analyzed. It is also examined that how filters can be used for restoring or reclaiming an image in such a way that the reclaimed image's maximum quality is achieved. This paper helps selecting the most preferable and efficient reclamation method in restoring degraded images.

The next question arises is, "What will be the future of technology, what will be the new innovations and what will be the digitization level in world after some years?" It is clearly visible from past some years that how rapidly technology has changed the world. In our paper suitable and efficient filters observed for different kinds of distorted and erupted images. But there is still a lot extra to arrive. We used reference images in grayscale to restore, but in future new filter techniques would be used for restoring colored images and may be for restoring videos

Table 1. Quality results of Various Restored Images

Test Images	Reclamation Methods	Restored Images			
		Additive Noise	**Motion Blur**	**Salt and Paper Noise**	**Speckle Noise**
Harbour Image	Wiener Filter	0.9923	0.9808	0.9894	0.9931
	Gaussian Filter	0.9957	0.9846	0.9836	0.9824
	Median Filter	0.9860	0.9821	0.9912	0.9852
Horse Image	Wiener Filter	0.9333	0.9526	0.9036	0.9796
	Gaussian Filter	0.9747	0.9711	0.9257	0.9214
	Median Filter	0.9386	0.9665	0.9781	0.9731

too just by some essential changes in the existing filtering/reclamation methods and their codes.

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