Image and Signal restoration: A review

Ghada Mohammad Tahir Kasim Aldabagh[1*]

Software Department

College of Computers Science and Mathematics

University of Mosul

Mosul, Iraq

Abstract:
Digital image processing deals with analysis, feature extraction and restoration of an image. Now day's image restoration is an important step for improvement in image. The restoration aims to reconstruct image which degraded on prior information. So the objective of image or signal restoration is to remove blur in image with the help of deblurring techniques. There are many techniques are available to recover the image by simply removing the degradation added during acquisitions like variable pixel value, noise, motion etc. These techniques are applicable to both spatial as well as frequency domain. Base of Image restoration is probabilistic models of image degradation. Hence It has wide scope since trends to recover image look best in appearance.In this paper, overview discussion of image restoration,different techniques of image restoration, types of various filter used for analysis was done.

Keywords: Image restoration, blur, Gaussian noise, wiener filter.

1. Introduction

Very primarily the image restoration field was involved in space program by scientist. That time program was done to get incredible images of the earth. In engineering it is needed to obtain important information from degraded image. Blurred image or degraded image is not a small problem [1].Banham M.R.and Kataaggelos A.K.were provided the article which is one the best collection of information for the beginners. So the commonly used algorithms comes in picture which are 1 dimensional in nature are retrieve the information.Today that term war introduced as image restoration.

Image restoration process is defined as recuperate an original image from degraded or blurred image by removing blur and noise. Generally, image is degraded at time of process of data acquisition. It involves loss of information due to quantization and sampling, blurring and different noises from the environment.

Avoiding Blur is very difficult task in many cases such as photography (camera shaking causes motion blur).Noise is an

unwanted signal which is added in image via sensor (It may be electrical or thermal signal) and environmental situation like snow, rain etc. Gaussian/Normal noise, Rayleigh noise, Erlang/Gamma noise, Exponential noise, Impulse/Salt and pepper noise, Uniform noise and Periodic noise are the few types of noises.

Electronic snapshot is termed as digital image .It is composition of picture element in grid form named as pixel. That pixel represents the quantized value which indicates specific point. Image restoration is responsible for the evaluation and formulation of image quality[2],[3] and[4].

1.1 Requirement of Image Restoration

In different field of atomic spectroscopy (planetary science) andsatellite imaging (restorative imaging)restoration of digital image is utilized as a part of different applications such ascrumbled and maturingfilms Restoration,Medical imaging, Astronomical imaging,examination,Defense, printing etc. [5] and [7].

Hence in that sense image restoration is actualized in various orders which include

attractive reaction and seismology imaging. It is depends on endeavor for enhancing the image with the help of information acquired by artificial process[6] and[7].

Images cannot be recaptured or retaken for the unique events such as tracking for highest mountain. Similarly in medical field it is must to capture image like x-ray without blur. Retaken of that images become dangerous to human being. So it is necessary to avoid of recapturing of X-ray [8].An application belongs to various fields such as astronomical imaging, medical imaging and forensic science. Improvement in quality for the degraded image may cause the complexity in algorithm as well as the increased cost.

1.2 Basic model of Image Restoration process:

Image Restoration process model is shown in bellows fig.1.This process deal with modeling of degradation and apply the inverse process to recover or reconstruct the image. Image restoration aim to compensate undo or for effects [9].
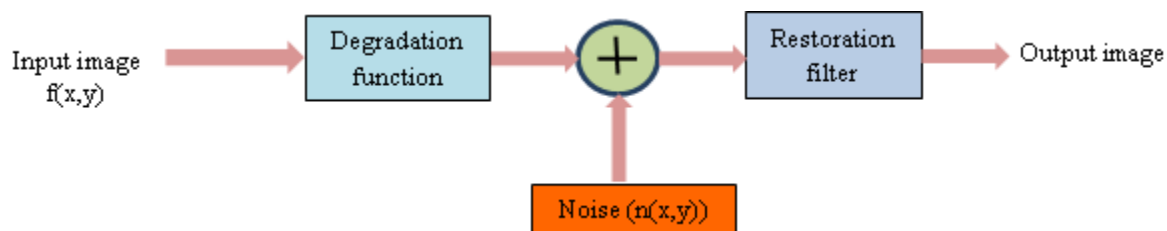
Fig. 1 Degradation model

Here input image is a two dimensional i.e. f (x, y). Degradation function is low pass filter.The h (x, y) is the system function i.e. channel matrix (it a free space travelling medium).External noise is added into the image so it becomes degraded image g(x, y).Mathematically g (x, y) is represented as

$$g(x,y) = h(x,y) * f(x,y) + n(x,y)$$
…………………..(1)

Degraded image   Reconstructed image

The equation 1 represent the blurred image .The target is to get output image approximate image to f (x,y). In linear system and space invariant system, the process of degradation can modeled byusing convolution.The issue of estimation of f from g(x,y) and h(x,y) is termed as deconvolution.

In various real world phenomenons were approximated to linear and space invariant. The nonlinear and space variant systems are highly accurate and general but they are very complex.

The rest of paper s summarized as: section 2 represents the types of noise, blur models, different restoration techniques (methods), Advantages and Disadvantages. Section 3 represents the literature for image

In linear and time invariant system model, there will be lots of challenges at time of inversion of the degradation model [10].

and signal restoration. Conclusion and references are listed in section 4 and 5.

Under this section,different scenarios with mathematical equations are discussed.

2.1 Noise Models

The major noise sources are image transmission or acquisition. Many factors are responsible for decreasing the performance of sensors. For e.g. higher gain amplification is required for low light, more amplification noise is present at high sensor temperature.Atmospheric disturbances OrLightning interference is responsible for the image corruption. On the basis of which noise is present, the appropriate model is selected [11].

Where, z=gray level, μ=mean and σ=standard deviation.

2.1.1 Gaussian Noise

In practice Gaussian noise models are frequently used sinceit's mathematical tractability in frequency and spatial domain. The Gaussian Pdf is given as

$$Gaussian_{noise} = \frac{1}{\sqrt{2\pi\sigma}} e^{\frac{(z-\mu)^2}{2\sigma^2}}$$

2.1.2Rayleigh noise:

It is defined as

$$p_{Rayleig\ h}$$
$$= \begin{cases} \frac{2}{b}(z-a)e^{\frac{-(z-a)^2}{b}} & z \geq a \\ 0 & z < a \end{cases}$$

2.1.3Erlangnoise:

The probable density function for Erlang noise given as

$$p_{erlang} = \begin{cases} \frac{a^b z^{b-1}}{(b-1)!} e^{-az} & z \geq 0 \\ 0 & z < 0 \end{cases}$$
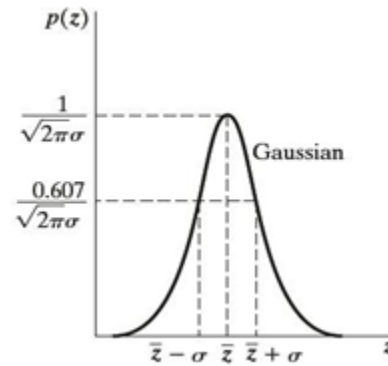
2.1.4Exponential noise:

Exponential noise is given by

$$p_{exponenetial} = \begin{cases} ae^{-az} & z \geq 0 \\ 0 & z < 0 \end{cases}$$

2.1.5Uniform noise:

Probable density function is given by

$$Uniform_{noise} = \frac{1}{b-a} \quad for\ a \leq z \leq b$$

$$= \ 0$$
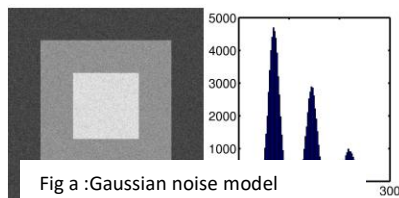
otherwise

2.1.6 Salt and pepper noise:

$$P_I(z) = \begin{cases} P_a & for\ z = a \\ P_b & for\ z = b \\ 0 & otherwise \end{cases}$$

Salt and pepper noise

Fig a :Gaussian noise model

Fig b :Rayleigh noise model

Fig c :Uniform noise model

Fig d :salt & Pepper noise model
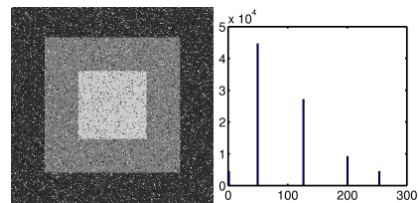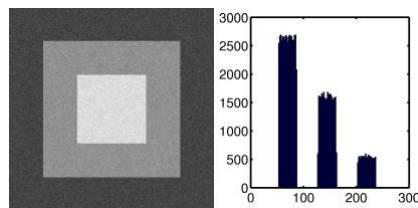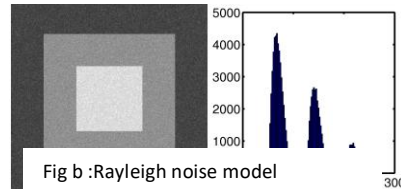
2.2 Blur model

2.2.1 Gaussian blur

In this image blurring filter Gaussian function is used to calculate transformation function.

Gaussian-blurred image

2.2.2 Motion Blur

Because of camera misfocus , the angle during capturing picture will go on changing hence in image Motion blur occurred.

Motion-blurred image

2.2.3 Rectangular blur

For specified rectangular area ,this blur is obtained. Blur is occurred anywhere in circular and rectangular area.

2.2.4 Defocus blur

Improper focusing on image causes the defocus blur. Resolution in image medium is depends on defocus. More tolerance shows lower resolution. Minimized image gives good resolution.

2.3 RestorationTechniques:

Different types of filter are used to reconstruct the filter.Median Filter,Adaptive Filter,IBD(Iterative Blind De-convolution) method, linearfilter, Non Negative and Support Constraints Recursive Inverse Filtering (NAS-RIF),Super-Resolution Restoration Algorithm based on Gradient Adaptive Interpolation,Deconvolution Using a Sparse Prior, Block Matching,Wiener Filter ,Deconvolution using Regularized Filter (DRF) and Lucy- Richardson Algorithm Techniques are the techniques used to reconstruct the degraded images[12].

2.3.1Adaptive Mean Filter:

It is a spatial domain filter. In this size of filter is variable. It gives satisfactory performance. An adaptive median filter keeps detail and smooth non-impulsive noise while median does not. It is only applicable for salt and pepper noise not for other types of noises. It does not remove any kind of blur. Order Static Filter, Alpha-trimmed mean Filter and Mean Filter are some filter are used for reconstruction for the image.But the wiener filter is more commonly used filter.

2.3.2 Restoration using Inverse Filter

The genral inverse filteris is obtained using following solution

$$H^T H \hat{f} = H^T y$$

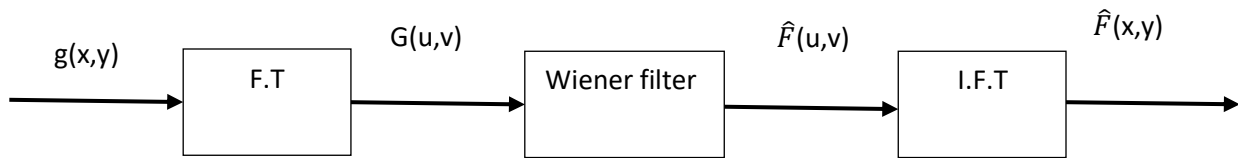As compared to inverse filter the wiener filter gives better result for restoration.Hence Improvement in inverse

filter result in wiener filter.Weiner filter persives an estimatation which minimise statical error function[13] and [14].

2.3.3 Restoration using Wiener Filter

The image is restored as

$$ResG(u,v) = H(u,v) \ F(u,v) + N(u,v)$$

$$F(u,v) = W(u,v) \ G(u,v)$$

Above fig shows the degraded image a reconstructed image using wiener filter. Recovered image
is not much clear but is identified than blur image[14] and [15].

Motion deblurring with a Wiener filter

For restoring the motion blurred image plays an important role in the security. Consider the example of reading the number plate of the car or any vehicle. Wiener plays an important role for this case. Bellows fig shows the blurred number plate image and reconstructed image.

### 2.3.4 Image Restoration using super-resolution
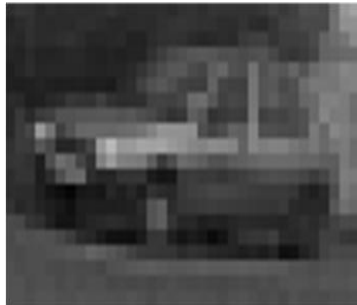
Result obtained by Super-resolution result for ROI

2.3.5 Image Restoration with blind deblurring

The Blind deconvolution termed as deconvolution method allows reconstruction of target image from single sample or "blurred" images set in attendance of weakly determined or an unknown point spread function (PSF)[16] .A known point spread function are utilized by regular nonlinear and linear deconvolution.
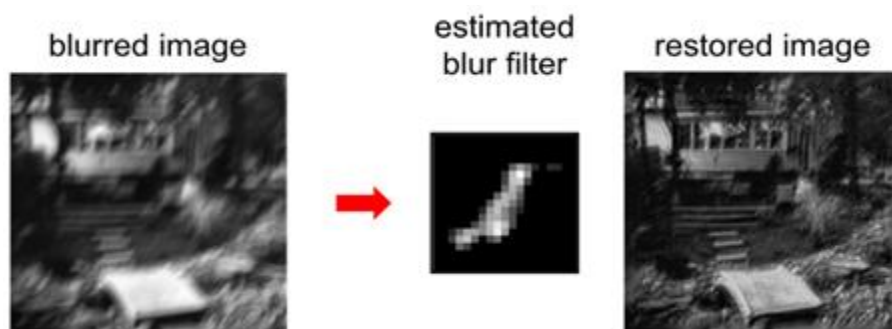
Result obtained by blind deblurring

Conclusion

Pompeii blurredGaussian noise   Result of direct inverse filtering

Result with Parametric Wiener filteringResult with Wienerfiltering

Many paper are available on image restoration as a literature. No of researchers was working on the issues of degradation of image. Blurring or restoration is very difficult issue to solve. Under this paper we studied various paper related to digital image and its features.

From the comparisons between them we conclude that the image restoration with wiener filter is good technique.

References:

1. Banham M.R.andKataaggelos A.K.(1997).Digital image Restoration. *IEEE signal processing magazine*,pp.24-41.
2. Er. Priya Tiwari, Dr. Naveen Dhillon and Er. Kuldeep Sharma(2013).Analysis of Image Restoration Techniques for Developing Better Restoration Method, *International Jounal Of Computer Application*,3(4),pp.1-5.
3. Shilpa Rani,Sonika Jindal and Bhavneet Kaur(2016).A Brief Review on Image Restoration Techniques.*International Journal of Computer Applications* , 150(12),pp.30-33.

4. Andrew, H. C. and B. R., Hunt ―Digital Image Restoration‖, Englewood Cliffs, NJ, Prentice-hall, 1977.

5. Biswa Ranjan Mohapatra, Ansuman Mishra, Sarat Kumar Rout ―A Comprehensive Review on Image Restoration Techniques‖, *International Journal of Research in Advent Technology*, 2(3), March 2014 E-ISSN: 2321-9637.

6. Himanshu Joshi and Dr. Jitendra Sheetlani()Image Restoration Techniques in Image Processing: An Illustrative Review.*Intenationaljounal of advance research in science and enginnering*, 6(1),pp.145-158.

7. VaiminRaval and Prof.LokeshGagnani (2012). Introduction to image restoration and comparison of various methods of image restoration. *International Journal of Advanced Research in Computer Engineering & Technology (IJARCET),*1(10), pp134-136

8. Ishfaq Bashir, Adil Majeed and Owais Khursheed(2017).Image Restoration And The Various Restoration Techniques Used In The Field Of Digital Image Processing. *International Journal of Computer Science and Mobile Computing*, 6(6), pg. 390-393.

9. Monika Maru and M. C. Parikh,Image Restoration Techniques: A SurveyInternational *Journal of Computer Applications* (0975 – 8887) ,160(6), February 2017 pp.15-19.

10. Deepa Puri and Prof. Santosh Kumar Mishra(2017).Analysis of Image Restoration Techniques at Different Noises. *International journal of computer science and information technology*,8(3) pp. 439-442.

11. Reginald L. Lagendijk and Jan Biemond (1999). Basic Methods for Image Restoration and Identification, pp1-25

12. David Miraut and Javier Portilla(2012). Efficient shift-variant image restoration usingdeformable filtering.*EURASIP Journal on Advances in Signal Processing*, pp.1-20

13. Ankita and Er. Lavina(2016). Research Paper on Image Restoration using DecisionBased Filtering Techniques . *International Journal of Engineering Development and Research* ,4(3),pp477-481

14. BatyrkhanSultanovichOmarov , AigerimBakatkaliyevnaAltayevaandYoungIm Cho (2015). Exploring Image Processing and Image Restoration Techniques. *International Journal of Fuzzy Logic and Intelligent Systems*,15(3),pp172-179.

15. CharuKhare and Kapil Kumar Nagwanshi(2012). Image Restoration Technique with Non Linear Filter. International Journal of Advanced Science and Technology,vol .39, pp 67-74.

16. KataaggelosA.K,janBiemond,Ronald Schafer M.Mersereau(1991).A regularized iterative image restoration algorithm.*IEEE transactions on signal processing*.39(4),pp914-929.