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Survey On Image Denoising Techniques

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Abstract: Image processing is a way to convert an image into digital form and perform some operation on it to obtain some useful information from it. The main aim of image processing is to visualization, Image sharpening and restoration, image retrieval, measurement of pattern, image recognition. In Digital Image Processing, the images are more prone to noise due to image capture and transmission. The image obtained after transmission is often corrupted with different types of noise.Digital images are contaminated by various types of noises such as Gaussian, Speckle and Impulse noise. In this survey different types ofnoises, degradation and restoration modelsare discussed. We also give a brief introduction about different types of filtering algorithms such as Mean filter, Median filter and Adaptive filters to reduce noise present in the digital image.

Keywords:
Image Noise, Denoising Filters, Restoration

I.INTRODUCTION

Removing or reducing noise in digital image is a key challenge in Digital Image Processing. In Image Processing, high quality images are essential to obtain high accuracy on feature extraction, classification etc.This paper deals with various filtering techniques for different types of noise such as Gaussian, Speckle and Impulse noise. The documentation of this paper is as follows. Section 2 is discussed about various types of noise model, Section 3 is discussed about degradation and restoration model. Section 4 is dealing with the different types of filtering algorithms and finally section 5 gives conclusion based on survey result.

II. NOISE MODEL

Noise means unwanted modification in the signal during capture, storage, transmission, processing or conversion. Image is corrupted by blurring effect or by noise too. The image captured after transmission is often corrupted with noise. Noise may be in Additive or Multiplicative form in an image.

Additive Noise Model:
Most images are affected to some extent by noise. Noise means unexplained variation in data. Additive noise[1] get added to the original image to form a corrupted noisy image. The following figure shows the additive noise mode. Addictive noise[7] model follows the following rule.

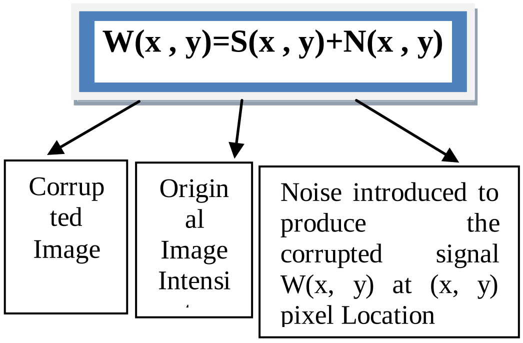


Figure 1:Additive noise Model

Multiplicative Noise Model:
Multiplicative noise[1] is nothing but unnecessary random signal that gets multiplied into some useful image during image capture, transmission or other processing.
(Eg) Speckle noise captured in radar imagery.
Multiplicative noise model follows the following rule

$$W(x, y)=S(x, y)*N(x, y)$$

Figure 2:Multiplicative Model

NOISES IN IMAGES:
To reduce these noises, prior learning of noise model[9] is important for further processing. There are different types of noise present in image that can corrupt the original image. Some of the noise are (i) Gaussian noise (ii)Speckle noise (iii)Impulse noise.

(i)Gaussian noise:

Gaussian noise[3] is also called Normal noise is randomly occurs as white intensity values, having probability distribution function equal to that of normal distribution. It is also called as Gaussian distribution.

Gaussian distribution noise can be expressed by,

$$P(x) = \frac{1}{(\sigma\sqrt{2\pi})} * e^{(x-\mu)z/2\sigma^2}$$

Where P(x) is the Gaussian distribution[5] noise in an Image, z represents the grey level(Gaussian random variable), μ and σ is the mean and standard deviation respectively.

(ii)Speckle noise:

Speckle noise[4] is also called data drop out noise. It is caused due to data transmission error. The following formula shows the speckle noise pattern.

Speckle noise pattern:

g(x , y))=f(x , y)*n(x , y)+n1(x, y)

Where g(x , y) is observed image, n(x, y) and n1(x , y) is the multiplicative and additivecomponent of speckle noise x, y denotes the axial and lateral indices of the image sample. Considered only the multiplicative noise component and ignore additive noise component then the above equation becomes like the following

g(x , y))=f(x , y)*n(x , y)

(iii)Impulse noise:

Impulse noise[2] is also called "Salt and Pepper" [6] noise or "Spike" noise. Salt and pepper noise means image contains dark pixels in bright region and bright pixels in dark regions. This type of noise can be introduced in an image due to analog to digital converter error , by dead pixels ,bit error during transmission etc.

Impulse noise pattern:

$$P(x) = \begin{cases} P1, & x=A \\ P2, & x=B \\ 0, & \text{otherwise} \end{cases}$$

Where P1, P2 are the Probabilities Density Function (PDF) p(x) is distribution of salt and pepper noise in image and A, B are the array size image.

III. DEGRADATION AND RESTORATION MODEL:

The degradation may cause due to sensor noise, camera misfocus etc . The degradation[3] may cause due to some other reasons like relative object, camera motion, to random atmospheric turbulence etc. The main focus on image restoration is to enhance or improve the quality of an image, identifies the type of noise and tries to reverse it.

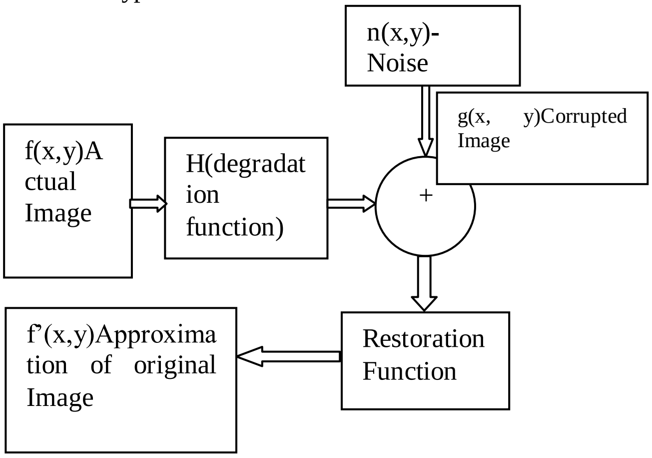


Figure 3:Degradation and Restoration Model

Image Restoration[10] techniques are used to recover original image from corrupted with prior knowledge of degradation process. Restoration process follows the following steps,

(1)Modeling of Degradation

(2)Apply the inverse process to recover the original image.

Restore image is not the original image. It is an approximation of the original image.

IV. FILTERS USED FOR RESTORATION PROCESS:

The main goal of image restoration is to remove the noise from the image in such a way that the original image quality will be retained. In an image, Filters[2] are used to re-evaluate the value of every pixel. Filters improve images by applying transformation function based on group of pixels. Depending on the application, one can select the denoising algorithm.

Spatial domain:

Spatial domain directly deals with the image matrix. It works on images as it is(no transformation required). In spatial domain the value of the pixels of the image changes with respect to scene. The following diagram illustrate the spatial domain model.

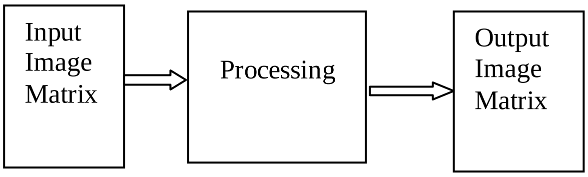


Figure 4:Spatial Domain

Spatial domain filters:

Image noise is the random variation of brightness or color information in image. Spatial domain filtering techniques are mostly used to remove random noise present in an image.

Frequency domain:

Frequency domain analyze image with respect to frequency. It deals with the rate at which the values of pixels changing in spatial domain. The following figure 5 shows the frequency domain model.

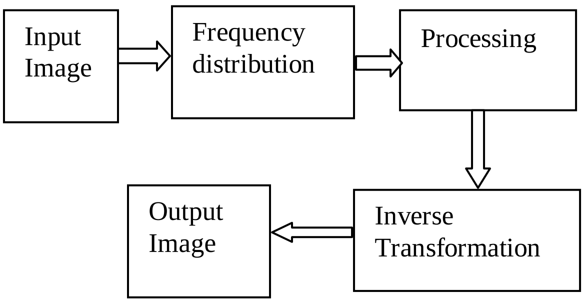


Figure 5:Frequency Domain

Steps followed in Frequency domain is as follows:

(i)Transform the image to its frequency domain.

(ii)Process the given image I.

(iii)Retransform the output of the processing unit(Inverse Transformation).

Transformation functions such as Fourier transform, Laplace transform and Z transform are used to convert images from the spatial into frequency domain. Mostly, Fourier transform are used to convert images from the spatial into frequency domain

Frequency domain filters:

Frequency domain filtering techniques are mostly used to remove periodic noise. Periodic noise arises due to electrical or electromagnetic interference.

Filters used for restoration process as follows,

(i)Mean filters

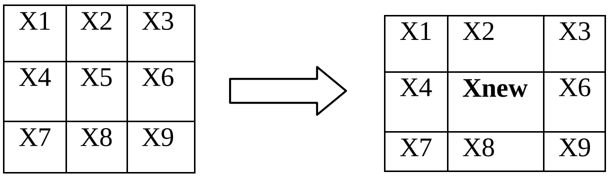
(ii)Order statistic filters (Median filters)

(iii)Adaptive filters

Mean Filters:

Mean filter[3] is also called as smoothing ,average and Box filter.Mean filters are defined by taking average of intensity value in a M*N region of each pixel. It is a sliding-window filter.

$$h(i,j) = 1/MN \sum_{k \in M} \sum_{i \in N} f(k,i)$$



Unfiltered ValueMean filtered value
(3*3 kernal)

Figure 6:Mean filter

The following formula is used to calculate the mean value of the kernel.

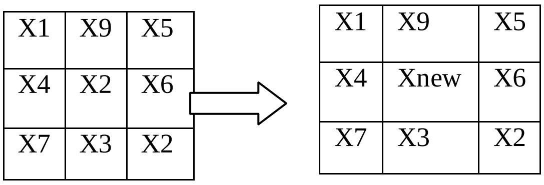
Meanvalue [Xnew]=[X1+X2+X3+X4+X5+X6+X7+X8+X9]/9

Meanvalue[Xnew]=[X1+X2+X3………Xn]/n

In this 3*3 kernal , center value X5 is replaced by the mean of all nine values. (ie Xnew)

Median filters:

Median filters[6][8] are also called Order statistic filters. This is very simple and non-linear filters. If multiplicative function based noise is present in the original image, this filter is widely adopted to remove such kind of noise . It is used to reduce the amount of intensity variation between one pixel and the other pixel.



Unfiltered Value Median filtered value
(3*3 kernal)
Figure 7:Median filter

The following formula is used to calculate the median value of the kernel.

Median value [Xnew] = [Sort the element in an ascending order and find the mid value]

Median value [Xnew] = [X1,X2,X3,X4,X5,X6,X7,X8,X9]

Xnew=X5

In this 3*3 kernal , center value X2 is replaced by the mean of all nine values. (ie Xnew)

Adaptive filters:

An adaptive filter is a filter containing coefficients that are updated by some type of adaptive algorithm to improve the filter response to a desired performance. Each and every adaptive filters have two parts. One is a linear filter and another one is adaptive algorithm.

The linear filters fall into the following filters type, such as (i) Finite Impulse Filters (FIP)[11] (ii) Infinite Impulse Filter (IIP)[11].Apply different algorithm to the adaptive filters to adjust the filter coefficients to minimize the cost function.

Cost function: J(n)=E[$e^2\,(n)$]

Where E is the expectation of $e^2\,(n)$ and $e^2\,(n)$ is the square of the error signal at time n.

Calculation of the cost function J(n):

The adaptive filter algorithms are used to calculate the cost function, falls into two broad categories .

(i) Least Mean Square (LMS) algorithms[12]

Cost function: J(n)=E[$e^2\,(n)$]

This algorithm uses the instantaneous value of $e^2\,(n)$ at time n as the estimation of E[$e^2\,(n)$].

(ii)Recursive Least Mean Square (RLS) algorithms[12]

Cost function: J(n)= 1/ N$\sum_{i=0}^{N-1} \lambda^i\, e^2\,(n-i)$

Where N is the filter length and λ is the forgetting factor(factor is(0,1)).This algorithm calculates not only the instantaneous value $e^2\,(n)$ but also past value such as $e^2\,(n-1)$,$e^2\,(n-2)$ ….$e^2\,(n-N+1)$.

V.CONCLUSION:

Removing noise from a digital image (Image de-noising)is an essential pre-processing task before processing images like segmentation, feature extraction, texture analysis etc. The motivation of this paper is to present a survey of digital image de-noising filters. We also give brief introduction about types of noise, various filtering techniques and degradation and restoration model. Each techniques, has its own advantages and disadvantages. This paper will be helpful for the researchers in understanding the concept of types of noise, filtering techniques, degradation and restoration model.

REFERENCES:

[1] Rajni, Anutam, "Image Denoising Techniques- An Overview ", International Journal of Computer Applications, January 2014, (0975 – 8887) Volume 86 – No 16.

[2] Priyanka Kamboj,Versha Rani, "A Brief Study Of Various Noise Model And Filtering Techniques", Journal of Global Research in Computer Science, Volume 4, No. 4, April 2013, © JGRCS 2010, All Rights Reserved 166 .

[3] Ravneet Kaur, Er. Navdeep Singh, "Image Restoration - A Survey ", IOSR Journal of Computer Engineering (IOSR-JCE) e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 16, Issue 4, Ver. III (Jul – Aug. 2014), PP 107-111 www.iosrjournals.org

[4] Prashant R. Deshmukh , Milindkumar V. Sarode , "Reduction of Speckle Noise and Image Enhancement of Images Using Filtering Technique", International Journal of Advancements in Technology http://ijict.org/ ISSN 0976-4860 Vol 2, No 1 (January 2011) ©IJoAT 30

[5] D.Napoleon, M.Praneesh,"Image Enhancement Of Under Water Images Using Structured Preserving Noise Reduction Algorithm ",International Journal of Computer Trends and Technology (IJCTT) – volume 4 Issue 10–Oct 2013 ISSN: 2231-2803 http://www.ijcttjournal.org Page 3697

[6] Pawan Patidar, Sumit Srivastava, Manoj Gupta, Ashok Kumar Nagawat," Image De-noising by Various Filters for Different Noise",International Journal of Computer Applications (0975 – 8887) Volume 9– No.4, November 2010

[7] Jonas Peters, Dominik Janzing, Bernhard Sch□olkopf,"Identifying Cause and E_ect on Discrete Data using Additive NoiseModels ",Appearing in Proceedings of the 13th International Conference on Arti_cial Intelligence and Statistics (AISTATS) 2010, Chia Laguna Resort, Sardinia, Italy. Volume 9 ofJMLR: W&CP 9. Copyright 2010 by the authors.

[8] Sivasundari .S, R. Siva Kumar, M.Karnan," Performance Analysis Of Image Filtering Algorithms For MRI Images ",IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308 ,Volume: 03 Issue: 05 | May-2014, Available @ http://www.ijret.org

[9] Ajay Kumar Boyat. Brijendra Kumar Joshi, "A Review Paper: Noise Models In Digital Image Processing ",Signal & Image Processing : An International Journal (SIPIJ) Vol.6, No.2, April 2015DOI : 10.5121/sipij.2015.6206 63