International Journal of Research
International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 05, May 2015
Available at http://internationaljournalofresearch.org

A Survey on X-Ray Image De-Noising by Various Filters for Different Noise

Sajid U. Khan
Universiti Malaysia Sarawak, Kuching, 94300, Malaysia
Email: sajdi786@yahoo.com

Shahid Ullah
Sarhad University, KPK, Paksitan
Email: sp_dhk@yahoo.com

Abstract:

Image de-noising is one of rich area in today research. Image processing allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and signal distortion during X-ray image acquisition or processing of images. Discrete Wavelet Transform is widely used for X-ray image de-noising. Some of the most popular filtersused for image de-noising are median filter (including all families), wiener filterwith all families and order filter. In this work,the basic four types of noise (Gaussian noise, Impulse noise, Speckle noise and Poisson noise) are taken in to account and tackle them with different de-noising filters.The aim of this work is to define that which filter is most efficient for the specific type of noise.Further results have been compared for all types of noise.

Keywords: Gaussian Noise; ImpulseNoise; Speckle Noise; Poisson Noise; Wiener Filter; Median Filter

I. INTRODUCTION

Pre-processing of X-ray images is a very important prospective. Without efficient pre-processing, we can't get best results from post-processing. Image de-noising is one of the most important prospective of pre-processing. There are many ways to de-noise an image or a set of data and methods exists. The important property of a good image de-noising model is that it should completely remove noise as far as possible as well as preserve edges. DWT is widely used for image de-noising (Han et al., 2008; He et al., 2008). Traditionally, there are two types of models i.e. linear model and non-liner model. The benefits of linear models are the speed and the limitations but these models are not able to preserve edges of the images in an efficient manner i.e. the edges, which are recognized as discontinuities in the image, are smeared out. On the other hand, Non-linear models can handle edges in a much better way than linear models. One popular model for nonlinear image de-noising is the Total Variation (TV)-filter.

The rest of the paper is organized as follows:-

- In the secondsection, we present different filters for noise reduction like Average/Mean filter, Median filter, Adaptive median filter and wiener filter.
- In the thirdsection, we described different typesof noise.
- Section 4 illustrates the simulation results and discussion.
- Section 5 presents conclusion and future work.

- Section 6 contains references.

II. TECHNIQUES FOR NOISE REMOVAL

A. MEAN FILTER:

It is used to remove noise (Patidar& Gupta, 2010). We can use linear filtering to remove certain types of noise. Certain filters, such as averaging or Gaussian filters, are appropriate for this purpose. For example, an averaging filter is useful for removing grain noise from a photograph. Because each pixel gets set to the average of the pixels in its neighborhood, local variations caused by grain are reduced.
Conventionally linear filtering Algorithms were applied for image processing. The fundamental and the simplest of these algorithms is the Mean Filter as defined in (Bovik, 2005).The Mean Filter is a linear filter which uses a mask over each pixel in the signal. Each of the components of the pixels which fall under the mask are averaged together to form a single pixel. This filter is also called as average filter. The drawback of Mean Filter is that it is poor in edge preserving.

B. *MEDIAN FILTER:*

The Median filter is a non-linear digital filtering technique often used to remove noise. It provides better results than mean filtering techniques because it preserves edges. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. Note that if the window has an odd number of entries, then the median is simple to define: it is just the middle value after all the entries in the window are sorted numerically. For an even number of entries, there is more than one possible median but the drawback is that if we take a large window i.e. 5*5 or 7*7 then it leads to blurriness (Khan, Wang, &Chai,2013).

C. ADAPTIVE MEDIAN FILTER:

The Adaptive Median Filter performs spatial processing to determine which pixels in an image have been affected by impulse noise. The Adaptive Median Filter classifies pixels as noise by comparing each pixel in the image to its surrounding neighbor pixels. The size of the neighborhood is adjustable, as well as the threshold for the comparison. A pixel that is different from a majority of its neighbors, as well as being not structurally aligned with those pixels to which it is similar, is labeled as impulse noise. These noise pixels are then replaced by the median pixel value of the pixels in the neighborhood that have passed the noise labeling test.

D. WIENER FILTER:

The goal of the Wiener filter is to filter out noise that has corrupted a signal. It is based on a statistical approach. Typical filters are designed for a desired frequency response. The Wiener filter approaches filtering from a different angle. One is assumed to have knowledge of the spectral properties of the original signal and the noise, and one seeks the LTI filter whose output would come as close to the original signal as possible (Kazubek, 2003). Wiener filters are characterized by the following:

a. Assumption: signal and (additive) noise arestationary linear random processes with known spectral characteristics.
b. Requirement: the filter must bephysically realizable, i.e. causal (this requirement can be dropped, resulting in a non-causal solution).
a. Performance criteria: minimum mean-squareerror.

International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 05, May 2015
Available at http://internationaljournalofresearch.org

III. X-RAY IMAGE NOISE

Before going to discuss sources/types of noise, first of all we will discuss that what noise is?
It is generally desirable for image brightness to be uniform except where it changes to form an image. There are factors, however, that tend to produce variation in the brightness of a displayed image even when no image detail is present. This variation is usually random and has no particular pattern. Sometimes, it reduces image quality and is especially significant when the objects being imaged are small and have relatively low contrast. This random variation in image brightness is designated noise.

Or

Simply Noise represents unwanted information which deteriorates the image quality. e.g. we have an image $f_{(i,j)}$ with noise $n_{(i,j)}$. Then the noisy image $g_{(i,j)}$ will be expressed in equation.

$$g_{(i,j)} = f_{(i,j)} + n_{(i,j)} \qquad \text{equ. 1}$$

Where g is noisy image, f is normal image and n is noise added to the image. Figure 1 (a) show the normal image while 2 (b) show the noisy image.

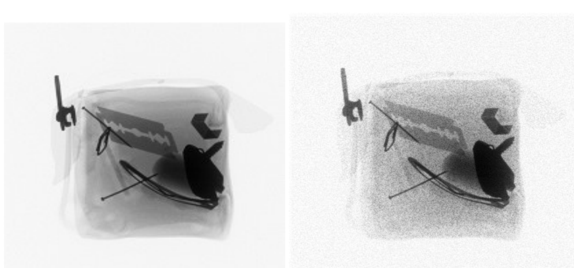

Figure 1: (a) Normal Image (b) Noisy Image

(Images are courtesy of FIA, KPK, Pakistan)

Below are the different kinds of noise.

- Amplifier noise (Gaussian noise)
- Salt-and-pepper noise
- Shot noise(Poisson noise)
- Speckle noise

A. GAUSSIAN NOISE:

The standard model of amplifier noise is additive, Gaussian, independent at each pixel and independent of the signal intensity. In color cameras where more amplification is used in the blue color channel than in the green or red channel, there can be more noise in the blue channel .Amplifier noise is a major part of the "read noise" of an image sensor, that's, of the constant noise level in dark areas of the image (Bovik, 2005).

B. IMPULSE NOISE:

An image containing salt-and-pepper noise will have dark pixels in bright regions and bright pixels in dark regions (Bovik, 2005). This type of noise can be caused by dead pixels, analog-to-digital converter errors, bit errors in transmission, etc. This can be eliminated in large part by using dark frame subtraction and by interpolating around dark/bright pixels.

C. POISSON NOISE:

Poisson noise or shot noise is a type of electronic noise that occurs when the finite number of particles that carry energy, such as electrons in an electronic circuit or photons in an optical device, is small enough to give rise to detectable statistical fluctuations in a measurement (Bovik, 2005).

D. SPECKLE NOISE:

Speckle noise is a granular noise that inherently exists in and degrades the quality of the active radar and synthetic aperture radar (SAR) images. Speckle noise in conventional radar results from random fluctuations in the return signal from an object that is no bigger than a single image-processing element. It increases the mean grey level of a local area. Speckle noise in SAR is generally more serious, causing difficulties for image

International Journal of Research
International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 05, May 2015
Available at http://internationaljournalofresearch.org

interpretation. It is caused by coherent processing of backscattered signals from multiple distributed targets. In SAR oceanography (Kent, Nuri Ocan&Ensari, 2004), for example, speckle noise is caused by signals from elementary scatters, the gravity-capillary ripples, and manifests as a pedestal image, beneath the image of the sea waves.

IV. SIMULATION RESULTS AND DISCUSSION

The data, which consist of 50 X-ray images, has been collected from the

i. Pakistan Civil Aviation Authority (PCAA) Pakistan, and
ii. Department of Computer Science, School of Engineering, Pontifical Catholic University of Chili.
The details of these images are as under:

X-ray images dataset contains original grayscale X-ray images with different noise types and densities and simulated X-ray images in Matlab R2009a as well. These images are in different size of 256*256, 512*512 and with 850*850, 1012*1012. These X-ray images are contaminated with Gaussian noise, Speckle noise, Salt & Pepper noise and Poisson noise with 70% noise density. The research work De-noised those X-ray images using Mean filter, Median filter, order filter and Wiener filter and comparisons among them. The simulation is done using Matlab R2009a.

Table 1 shows the results for different types of noise. After de-noising each image by using different techniques, we compute the Mean Square Error (MSE) and Peak Signal to Noise Ratio (PNSR) to compare the results.

Technique / Noise Type	**Salt & Pepper Noise**	**Gaussian Noise**	**Speckle Noise**	**Poisson Noise**
Noisy Image	MSE: 27.3970 PNSR: 33.9730	MSE: 21.7637 PNSR: 34.7875	MSE: 29.1188 PNSR: 33.5231	MSE: 13.1989 PNSR: 36.9594
Mean Filtering	MSE: 26.2528 PNSR: 35.9730	MSE: 20.7206 PNSR: 36.0008	MSE: 27.0419 PNSR: 34.8444	MSE: 13.5816 PNSR: 36.8353
Median Filtering	MSE: 18.3811 PNSR: 39.7895	MSE: 16.1122 PNSR: 42.9182	MSE: 26.8589 PNSR: 35.5620	MSE: 12.8782 PNSR: 38.0663
Order Filtering	MSE: 38.7873 PNSR: 34.2779	MSE: 21.1472 PNSR: 35.8153	MSE: 38.5806 PNSR: 33.7944	MSE:13 .1737 PNSR: 37.0898
Wiener Filtering	MSE: 27.9725 PNSR: 37.4032	MSE: 19.8968 PNSR: 37.8867	MSE: 22.5660 PNSR: 35.6303	MSE: 10.4653 PNSR: 39.5709

TABLE 1 shows the results of noisy X-ray image

The results in the table1 show that median filter is most suitable for Impulse/Salt &Pepper noise while Wiener filter is best for Poisson noise.

This work clearly depicts the basic point of Poisson noise. Due to less penetration, randomly dropping of photons and size of detector matter, X-ray images are normally degraded with Poisson noise and much of work shows that normally median filter are its families are used to filter X-ray images that's why we are still facing dishonest results.

V. CONCLUSION

We used the FIAAirport luggage Image that is contaminate with four different types of noise (Salt & Pepper, Gaussian, Speckle, and Poisson) in original image with 70% noise density. De-noised all noisy images by all filters and conclude from the results that:

e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 05, May 2015
Available at http://internationaljournalofresearch.org

The performance of the median filter is best for Impulse noise and wiener filter is more efficient for Poisson noise.

REFERENCES

[1]. Ping, H., Xiu-Ping, H., Si-yuan, J., & Ren-biao, W. (2008). An efficient enhancement technique of X-ray carry-on luggage images.9th International Conference on Signal Processing, 1170-1173.doi:10.1109/ICOSP.2008.4697338.

[2].Ping, W., Junli, L., Dongming, L., & Chen, G. (2007). A fast and reliable switching median filter for highly corrupted images by impulse noise.*IEEE International Symposium on Circuits and Systems, ISCAS 2007,*3427-3430, 10.1109/ISCAS.2007.378363.

[3] Pawan, P., Manoj, G., Sumit, S., & Ashok, K. N. (2010). Image De-noising by Various Filters for Different Noise.*International Journal of Computer Applications, 9*(4), 0975 – 8887.

[4] Bovik, A. C. (2005). Image Noise Models, *Handbook of Image and Video Processing, (2nd Ed.)*1355-1372. doi: 10.1016/B978-0-12-119792-6.50139-X Retrieved from http://books.google.com.my/books?id=UM_GCfJe88sC&pg=PA17&dq=%E2%80%9DImage+Noise+Models%E2%80%9D+in+Alan+C.+Bovik.+Handbook+of+Image+and+Video+Processing.&hl=en&sa=X&ei=mSiDVOyuMcWiugTB84KIBA&ved=0CB0Q6AEwAA#v=onepage&q=%E2%80%9DImage%20Noise%20Models%E2%80%9D%20in%20Alan%20C.%20Bovik.%20Handbook%20of%20Image%20and%20Video%20Processing.&f=false.

[5]. Khan, S. U., Wang, Y. C., & Chai, S. S. (2013). A Novel Noise Removal Technique of X-Ray Carry-on Luggage for Detection of Contraband/Illicit Object(s).*International Journal of Engineering and Advance Technology, (IJEAT*), *2*(3).Retrieved from http://www.ijeat.org/attachments/File/v2i3/C1021022313.pdf.

[6]. Kazubek.(2003).Wavelet domain image de-noising by thresholding and Wiener filtering.*Signal Processing Letters*, IEEE, 10(11).

[7]. Kent, S., Nuri Oçan, O.,&Ensari, T. (2004). Speckle Reduction of Synthetic Aperture Radar Images Using Wavelet Filtering. In astrium.EUSAR 2004Proceedings, 5th European Conference on Synthetic Aperture Radar, May 25–27, Ulm, Germany.