A Review on Removal of Salt and Pepper Noise from Digital Images

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Abstract - *Image restoration is the process of restoring degraded images which cannot be taken again or the process of obtaining the image again is costlier. We can restore the images by prior knowledge of the noise or the disturbance that causes the degradation in the image. Image restoration is done in two domains: spatial domain and frequency domain. In spatial domain the filtering action for restoring the images is done by directly operating on the pixels of the digital image. In frequency domain the filtering action is done by mapping the spatial domain into the frequency domain by taking fourier transform of the image function. By mapping the image into frequency domain an image can provide an insight for filtering operations. After the filtering, the image is remapped into spatial domain by inverse fourier transform to obtain the restored image. Different noise models were studied. Different filtering techniques in both spatial and frequency domains, were studied and improved algorithms were written and simulated using matlab. Restoration efficiency was checked by taking peak signal to noise ratio (psnr) and mean square error(mse) into considerations.*
Keywords *– PSNR,Median filter,MSE,Image Processing*

I. INTRODUCTION

The aim of digital image processing is to improve the potential information for human interpretation and processing of image data for storage, transmission, and representation for autonomous machine perception. The quality of image degrades due to contamination of various types of noise. Additive white Gaussian noise, Rayleigh noise, Impulse noise etc. corrupt an image during the processes of acquisition, transmission and reception and storage and retrieval.
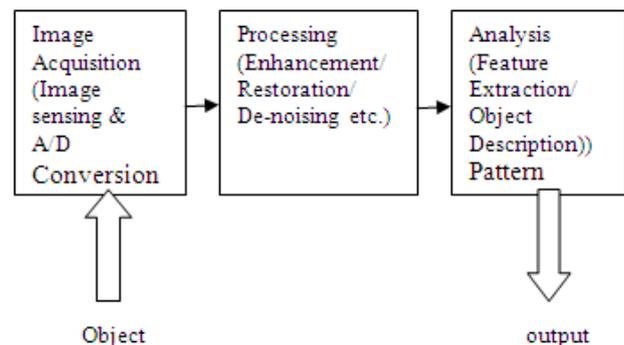

Figure1. Steps in image processing

Image processing functions:

- Image Transformation
- Image Processing
- Image Enhancement
- Image Restoration
- Color Image Processing
- Transform-Domain Processing
- Image Compression
- Morphological Image Processing
- Image Representation and Description
- Object Recognition

Image processing techniques:

As has just been established, a number of factors can adversely affect RTR image quality. With the use of image enhancement techniques, the difference in sensitivity between film and RTR can be decreased. A number of image processing techniques, in addition to enhancement techniques, can be applied to improve the data usefulness. Techniques include convolution edge detection, mathematics, filters, trend removal, and image analysis. The various image enhancements and image processing techniques will be introduced in this section. Computer software programs are available, including some or all of the following programs:

Enhancement programs make information more visible.

- Histogram equalization-Redistributes the intensities of the image of the entire range of possible intensities (usually 256 gray-scale levels).
- Unsharp masking-Subtracts smoothed image from the original image to emphasize intensity changes.

Convolution programs are 3-by-3 masks operating on pixel neighborhoods.

- Highpass filter-Emphasizes regions with rapid intensity changes.
- Lowpass filter-Smoothes images, blurs regions with rapid changes.

Math processes programs perform a variety of functions.

- Add images-Adds two images together, pixel-by-pixel.
- Subtract images-Subtracts second image from first image, pixel by pixel.
- Exponential or logarithm-Raises e to power of pixel intensity or takes log of pixel intensity. Nonlinearly accentuates or diminishes intensity variation over the image.
- Scaler add, subtract, multiply, or divide-Applies the same constant values as specified by the user to all pixels, one at a time. Scales pixel intensities uniformly or non-uniformly
- Dilation-Morphological operation expanding bright regions of image.
- Erosion-Morphological operation shrinking bright regions of image.

Noise filters decrease noise by diminishing statistical deviations.

- Adaptive smoothing filter-Sets pixel intensity to a value somewhere between original value and mean value corrected by degree of noisiness. Good for decreasing statistical, especially single-dependent noise.
- Median filter-Sets pixel intensity equal to median intensity of pixels in neighborhood. An excellent filter for eliminating intensity spikes.
- Sigma filter-Sets pixel intensity equal to mean of intensities in neighborhood within two of the mean. Good filter for signal-independent noise.

Trend removal programs remove intensity trends varying slowly over the image.

- Row-column fit-Fits image intensity along a row or column by a polynomial and subtract fit from data. Chooses row or column according to direction that has the least abrupt changes.

Edge detection programs sharpen intensity-transition regions.

- First difference-Subtracts intensities of adjacent pixels. Emphasizes noise as well as desired changes.
- Sobel operator-3-by-3 mask weighs inner pixels twice as heavily as corner values. Calculates intensity differences.
- Morphological edge detection-Finds the difference between dilated (expanded) and eroded (shrunken) version of image.

Image analysis programs extract information from an image.

- Gray-scale mapping-Alters mapping of intensity of pixels in file to intensity displayed on a computer screen.
- Slice-Plots intensity versus position for horizontal, vertical, or arbitrary direction. Lists intensity versus pixel location from any point along the slice.
- Image extraction-Extracts a portion or all of an image and creates a new image with the selected area.
- Images statistics-Calculates the maximum, minimum, average, standard deviation, variance, median, and mean-square intensities of the image data.

II. LITERATURE REVIEW

Recently, there have been significant research works on security mechanism used in WSNs. This section covers the literature survey of the work of the paper.

[1]Peixuan Zhang and Fang Li proposed a new adaptive weighted mean filter (AWMF) for detecting and removing high level of salt-and-pepper noise. For each pixel, we firstly determine the adaptive window size by continuously enlarging the window size until the maximum and minimum values of two successive windows are equal respectively. Then the current pixel is regarded as noise candidate if it is equal to the maximum or minimum values, otherwise, it is regarded as noise-free pixel. Finally, the noise candidate is replaced by the weighted mean of the current window, while the noise-free pixel is left unchanged. Experiments and comparisons demonstrate that our proposed filter has very low

detection error rate and high restoration quality especially for high-level noise

[2]Faruk Ahmed and Swagatam Das Proposed a novel adaptive iterative fuzzy filter for denoising images corrupted by impulse noise. It operates in two stages—detection of noisy pixels with an adaptive fuzzy detector followed by denoising using a weighted mean filter on the "good" pixels
in the filter window. The filter is also shown to be robust to very high levels of noise, retrieving meaningful detail at noise levels as high as 97%.

[3]Weiyang Mul ,Jing Jin! ,Hongqi Feng2 ,Qiang Wangl Proposed an algorithm called adaptive window multistage median filter for image salt & pepper denoising. Experiments results demonstrated its superiority over other methods when the percentage of salt & pepper noise is less than 20.

[4]Yi Wan, Jiafa Zhu and Qiqiang Chen There are two separate approaches to removing salt-and pepper noise: the median type filtering and the variational formulation. The first approach usually has fast speed, while the latter produces greatly improved result at much slower speed. In this paper we show that the variational approach can be approximated as a region growing process and proposed a novel iterative algorithm that combines the strength of these two approaches. When viewed within a single iteration, the algorithm acts like a median type filter. When viewed across iterations, the filter achieves the region growing effect accomplished by the variational approach. Extensive simulations show that the proposed algorithm achieves the state of the art performance with the fastest speed published so far. The insight gained in this paper could have broader applications.

[5]S. Esakkirajan, T. Veerakumar, Adabala N. Subramanyam, and C. H. PremChand proposed algorithm replaces the noisy pixel by trimmed median value when other pixel values, 0's and 255's are present in the selected window and when all the pixel values are 0's and 255's then the noise pixel is replaced by mean value of all the elements present in the selected window. This proposed algorithm shows better results than the Standard Median Filter (MF), Decision Based Algorithm (DBA), Modified Decision Based Algorithm (MDBA), and Progressive Switched Median Filter (PSMF). The proposed algorithm is tested against different grayscale and color images and it gives better Peak Signal-to-Noise Ratio (PSNR) and Image Enhancement Factor (IEF).

[6]Changhong Wang, Taoyi Chen, and Zhenshen Qu Proposed a novel improved median filter algorithm for the images highly corrupted with salt-and-pepper noise. Firstly all the pixels are classified into signal pixels and noisy pixels by using the Max-Min noise detector. The noisy pixels are then separated into three classes, which are low-density, moderate-density, and high-density noises, based on the local statistic information. In experiment, the proposed algorithm is compared with three typical methods, named Standard Median filter, Extremum Median filter and Adaptive Median filter, respectively. The validation results show that the proposed algorithm has better performance for capabilities of noise removal, adaptivity, and detail preservation, especially effective for the cases when the images are extremely highly corrupted.

[7]Medhavi Aggarwal, Ranjit kaur and Beant kaur Proposed to analyse various image restoration or denoising techniques. These techniques help us to recover the original image from the degraded image while maintaining the originality of the image as much as possible.

[8]Raymond H. Chung-Wa Ho, and Mila Nikolova Proposed a two phase scheme for removing salt-and-pepper impulse noise. In the first phase, an adaptive median filter is used to identify pixels which are likely to be contaminated by noise (noise candidates). In the second phase, the image is restored using a specialized regularization method that applies only to those selected noise candidates. This scheme can remove salt-and-pepper-noise with a noise level as high as 90%.

[9]Swati Sharma, Shipra Sharma,and Rajesh Mehra Proposed theis algorithm has been compared with Wiener filter, Constraint Least square method and Lucy Richardson algorithm. The performance comparison dine on the based on peak signal-to-noise ratio. The result shows that Modified Lucy Richardson method is better than Wiener filter, Constraint Least Square method and Lucy Richardson algorithm.

[10]E.Jebmalar Leavline, D.Antony Gnana Singh Proposed impykse biuse removal using the standard median filter and its variants are analyzed. Extensive simulations have been carried out on a set of standard gray scale images and the state of the art median filter variants are compared in terms of the well known image quality assessment metrics namely mean square error, peak signal to noise ratio and multiscale structural similarity index.

[11]Mohd Dilshad Ansari, Garima Singh, Arjun Singh, Ashwani Kumar Proposed two phase scheme for removing salt and pepper noise and edge preservation: in the first phase Adaptive median filter is used to detect corrupted pixel and preserving the edges. In the second phase Non-Local Means algorithm is used in order to have better quality of

reconstitution. The proposed algorithm works well in removing salt and pepper noise at high density and preserving edges smoothly and fine detail of image compare to others

III. CONCLUSION

Among mean filters, geometric mean filter smoothens images and loses less image detail. Harmonic filter works best with salt noise only. Contraharmonic mean filter can be used to filter both salt and pepper noise combined. Median filters are effective in presence of nipolar and bipolar impulse noise. Max filter is useful for finding brightest points and thus reduces pepper noise. Min filter is useful for finding darkest points and thus reduces salt noise. Midpoint filters work best for randomly distributed noise like gaussian noise or uniform noise. Alpha-trimmed mean filter is useful in situations involving multiple noise, such as combination of salt and pepper noise and Gaussian noise. Low pass filters are used in image smoothening. High pass filters are used in image sharpening. Adaptive local filters help in reducing local variances in an image. Frequency domain filters such as high pass filters help in preserving the image details such as edges. The work done is only on gray scale images. It can be extended to coloured images. Image restoration mainly required prior knowledge of the degradation function. Techniques can be developed to estimate these degradation functions more accurately.

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